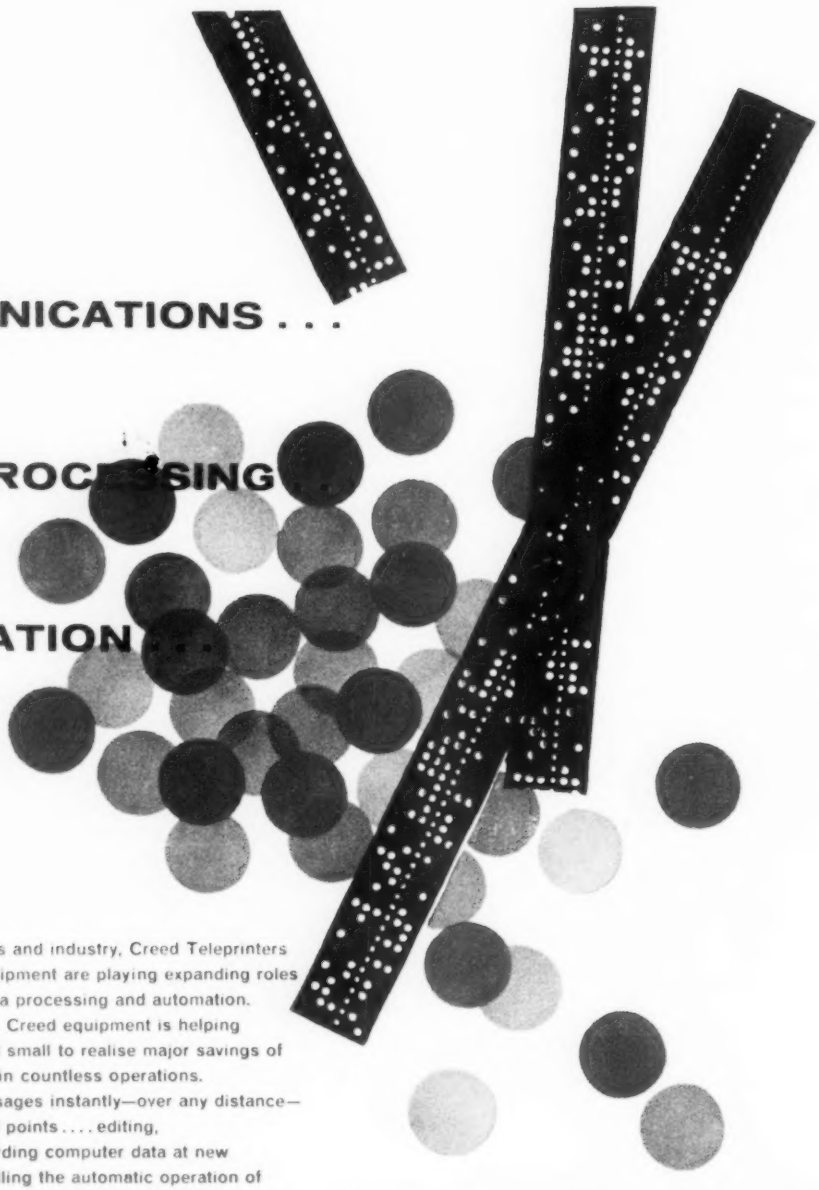
AUTOMATIC DATA PROCESSING

Manual methods to electronics—in one hop

Taking stock of computer languages

Research today

Shell-BP's push-button office



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AUTOMATIC DATA PROCESSING VOL 2 No 10 CONTENTS OCTOBER 1960

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AUTOMATIC DATA PROCESSING

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Too Good to Miss?

THREE years ago in a book entitled *Electronics in the Office*, put out by the Office Management Association, an executive from Shell-Mex and BP Ltd wrote about a non-electronic automatic office that had been envisaged by his company and which they intended to build. Two weeks ago the news was released that the company were in fact operating such an office, albeit on an experimental basis. Between hitting on the original idea and producing the present office there has been time to modify the idea and make changes to the blueprint, but the present system* embodies still two characteristics which Shell-Mex and BP were always anxious it should have: it is accurate and it is inexpensive. It is the most stimulating development of 1960.

The Shell-Mex and BP system is a complex of equipment which modestly produces invoices and sales tickets for immediate release, while retaining sales information for further processing. So far, it does not greatly excite, nor does it sound novel—an accounting machine equipped with a tape punch could, it seems, do as much. The difference is that it is a push button system: after depressing a number of buttons for name, product, quantity and the like, the system does all the work, selecting the information required from its own files. In effect, the system is built round files of pre-prepared information about customers, discounts, products and prices, which at a push on several buttons can be readily retrieved.

The principle is certainly not revolutionary. Probably quite a number of companies boast computer billing routines which depend on first storing the basic data. However, this system is not electronic—it is electro-mechanical and consequently much cheaper to build than an electronic system. Hence it is possible to envisage installing several of these systems. This is not necessarily what Shell-Mex and BP intend to do, for their first automatic office is still considered as an experiment, but it opens up a new possibility which many companies might profitably examine.

DORIS, to give the system its name, was of course designed to solve some of the problems encountered in an oil marketing company with many distribution centres, but Doris-type equipment might well be applied to almost any organisation that sells from stock or even that has to keep track of raw materials or partly finished products or of goods issued by factory stores. The prospect of initiating automatic data processing by pushing buttons, instead of the more cumbersome ways currently available, has a great deal of attraction, and must be too good to miss.

* An article on this system (named DORIS from Direct Order-handing and Invoice System), appears on page 16

E.M.I. delivers...

Three dates in Computer history:

APRIL 20, 1960: EMI delivers an EMIDEC Computer to Boots Pure Drug Co. Ltd.

MAY 18, 1960: An EMIDEC Computer delivered to Glaxo Laboratories Ltd.

JUNE 15, 1960: An EMIDEC Computer delivered to I.C.I. (Plastics Division).

Now with these three deliveries EMI inaugurates a new era in Computers; an era in which the electronic calculator, modified from older machines designed for scientific purposes, will be replaced in Commerce and Industry by the true Computer—an all-transistor machine designed from the start to provide a comprehensive decision-making system aiding managements of business, commerce and industry.

There will be regular monthly deliveries from now on, and fifteen of Britain's leading organisations are already working with EMI, gaining experience of the benefit to be obtained from installing THE Computer —for EMIDEC is THE working COMPUTER being delivered now.

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EE122

The column for fast access to random information

Photo: IBM

Tabs on Tobacconists

Second computer for Wills

One of the significant factors affecting the decision of cigarette manufacturers W D & H O Wills to order a second Leo II for their Bristol works has been their desire to extend the records of customer purchasing patterns—now confined to the Western Region—to cover the whole country. The recording of these purchasing patterns by means of a computer has been a recent development among large-scale manufacturing-and-distributive firms, the most recent giant to adopt them being the Courtauld organisation.

With the diversity and proliferation of the small retail outlets that make up Wills' customers—there are 40,000 in the Western Region alone—the variables are considerable. This several-month survey of patterns are proving invaluable as a sales aid to representatives, and as a method of control for supervisors and area sales managers.

The new Leo II, which is equipped with an ultra-rapid random access store—a 15,000-word magnetic store controlled by transistorised circuits—will also be responsible, with the first Leo, for the processing of orders, sales accounting and invoicing for all Wills' customers. With the first Leo it was possible to process all orders for the Western Region the same day and pass them for despatch to the warehouses. With the two computers it is possible to extend this service to all Wills' customers, without any extension of the delivery time. This is the first data processing installation in the UK to make use of two large computers, and it is also the largest load of sales accounting and invoicing to be handled at any one time by a single installation.

Service Consultants

Computer time for sale

'Modern industry needs modern techniques to solve modern large-scale problems—and that means applying analytical and mathematical methods'—the speaker was Dr Herbert W Robinson, who heads the American scientific consultancy firm, Corporation for Economic and Industrial Research, on a visit to Britain recently to launch a British subsidiary to CEIR.

First set up seven years ago, CEIR have firmly established themselves as consultants 'with a difference'; a turnover of six and a half million dollars and a staff of 300 consultants proves this. That the 300 are statisticians, economists, physicists, market researchers and computer technicians underscores that CEIR are a rare organisation among the management consultancy fraternity. Having handled problems of operation, administration, marketing, data processing, expansion and research for a number of clients, they, of course, hope to cover the same range in Britain. On the data processing side, they will aid and abet managements to consider, instal and run data processing installations.

Appointed managing director of the British venture is Mr Tom Cauter, a past-president of the Market Research Society of Great Britain, and he will have as a director of technical services Dr A Douglas, who previously was director of the Computing Laboratory at Leeds University.

In the USA CEIR are also in the computer time hire business—at their Arlington Research Centre (claimed to be the largest independent commercial computer centre in the world) they have recently taken on the strength an IBM 7090.

The British company will also operate a computer service centre, and have just arranged for the provision of computer facilities with a computer manufacturer (rumoured to be IBM). When this machine arrives CEIR (UK) Ltd will be the first independent company to enter the time-hire business.

The MICR Race

Uttley's men report

Man of the moment (for some manufacturers) is Dr A M Uttley, Autonomics Superintendent of the National Physical Laboratory, whose independent report on the three magnetic ink codes for automatic cheque sorting was delivered to the electronics sub-committee of the London clearing banks a few days ago. Some five months back the committee briefed Dr Uttley to investigate the technical potential and advantages of the three codes under consideration—the CMB magnetic code of De la Rue Bull, the E 13B magnetic character system of the American Banking Association and EMI Electronics' FRED.

UTTLEY

briefed to investigate

Dr Uttley's three-man team, led by Mr Donald Davies, have now completed their researches, which involved them in travelling to the USA and France, to see machines in operation. Their report, running into many pages, and heavy with diagrams and statistics, is now being considered by the banks' committee, whose decision should be promulgated in a matter of weeks. While the report—which is a purely technical one—and does not delve into economics, will not be published, its conclusions will soon be apparent.

Handy Pliers

Others should teach

'If any Chancellor starts thinking on the lines of using computers as an aid to taxation,' said Mr Sebastian de Ferranti, amid laughter, 'I consider I am extremely well placed to retaliate by investigating the use of computers for tax avoidance.' Mr de Ferranti, managing director of Ferranti Ltd, was addressing the British-Swedish Chamber of Commerce in Stockholm on the theme of the 'ubiquitous computer.' It was, he said, as basic to the thinker in figures as the pair of pliers to the handyman, and had an inherent ability to deal with any problem which could be experienced in numerical or pseudo-numerical form. In the early days it was thought that two or three computers would meet the needs of an industrial country; in the UK alone today there were 200 computers in operation and many more on order. Production figures in 1959 were valued at £3,809,000, as opposed to £90,000 in 1953, and of this £1,322,000 were for export orders.

In atomic physics, most of the advances were dependent on large computers; in engineering the computer was actually being programmed to produce, by evaluating and discarding many hundreds or thousands of designs, the most suitable design for the purpose. In real time applications, optimal planning, flight control and commercial data processing the computer's assistance was invaluable.

Mr de Ferranti dealt frankly with the cost factor. No computer doing just one job was really being used to best advantage. The economics of modern computer working favoured the large, fast machine. The computers with the highest speeds—which were naturally the most expensive—would give the greatest value for money; users might well prefer to hire time on a large computer in a service centre rather than own a small computer themselves.

DE FERRANTI

. . . hand over a responsibility

Usually the computer affords a means of getting results more accurately and more cheaply, though on the straight question, whether it was cheaper to do a job by computer or by clerical labour, the answer had sometimes gone against the computer.

Mr de Ferranti paid tribute to the work being done at the Centre of Management Studies at Glasgow, but appealed to the universities and training colleges of Europe to meet the need for scholarly thought and the problem of the computer age; he would like to hand over the responsibility, which computer manufacturers now carried, for teaching the world of trade and administration how these electronic aids to data handling could be used most wisely.

New Home

. . . to house computer centre

Into a new office block in High Holborn moved Remington Rand recently. Remington House, where the company's office equipment, business service, and O & M divisions have now been centralised, is an impressive looking glass and concrete building on the corner of Holborn Viaduct and Snow Hill. The new address of the company is 61-65, High Holborn, E C 1. A Univac 80 computer is to be installed early in the New Year. It will be used for customer service, training, testing and programming. It is not anticipated that this computer will be used for time hiring on a service basis, at least not in the foreseeable future. But what of the UNIVAC III?

REMINGTON HOUSE
No time-hire here

Remington recently advertised for programmers and system analysts to be trained on a 'new and very complete range of electronic computing systems' to be marketed in the UK. First of these systems was the Univac III. But since that first brief announcement little has been heard about the system from Remington.

Computer-in-Law

Bar Association see system demonstrated

The America Bar Association some little time back appointed an electronic data retrieval committee to look into the possibilities of legal research by machine. The recent demonstration before the Bar Association of machine retrieval of legal information would seem to suggest that they have gone some way towards overcoming the difficulty of establishing legal definitions, which could be universally applicable.

Statute law relating to health and hospitals, oil and gas law, product liability, patent design, negligence labour law, was fed into the machine and stored on magnetic tape, together with the words expected to be contained in them. When information was being retrieved the machine would automatically search the vocabulary thus created, and put out the appropriate information in a matter of minutes.

The advantages of the use of machine retrieval lie in the speedy availability of information, the automatic sorting into categories—eliminating searching, the continuity of control, and the reduction in volume and expense of copying. This method will allow the professional man, the doctor or scientist, no less than the lawyer, to keep track of case histories, reports, and papers necessary for their work.

Best for Cables

Quicker ionospheric predictions

The Australian Department of the Interior is using a National-Elliott 405 at the Sydney Electronic Data Processing Centre with some very remarkable results! To calculate the best times for sending overseas cables or making radio-telephone calls it formerly needed a team of mathematicians working full-time. Nor could the department be wholly reliant on the accuracy of this ionospheric prediction, as this calculation was called, because so great a mass of variable information had to be received and processed from no less than 60 stations situated all round the world.

By using the 405, however, a very much higher level of accuracy can be assured. And where it formerly took the team five years to revise the basic predictions for the world, the computer, working only one hour every two months, can do the whole job in a total time of six hours per year.

Closing Estuaries

Survey work inspected

Visitors to the recently held Ninth International Congress of Photogrammetry have been making the journey up to Southgate, London, to see demonstrations of computer programs of photogrammetric survey work at the computer centre of Standard Telephone and Cables Ltd. Highlight of the demonstration has been the use of a Stantec Zebra computer to prepare the surveys for the ultimate closing of the estuaries between the Rotterdam waterway and the West Scheldt. The Zebra co-ordinated points, situated on lines which together formed the idealised Decca navigation pattern, at a rate of 3,000 points per hour. In this way 300,000 points were co-ordinated and referred to the rectangular co-ordinate system on the stereographic projection in land triangulation. Zebra has also been used for photogrammetry projects in Switzerland, and the programs on show have included computational work used in these surveys, as well as calculations for closed traverses with intersected points, and distances measured with the Wild horizontal invar staff.

RAF Order

Per ardua ad AEI

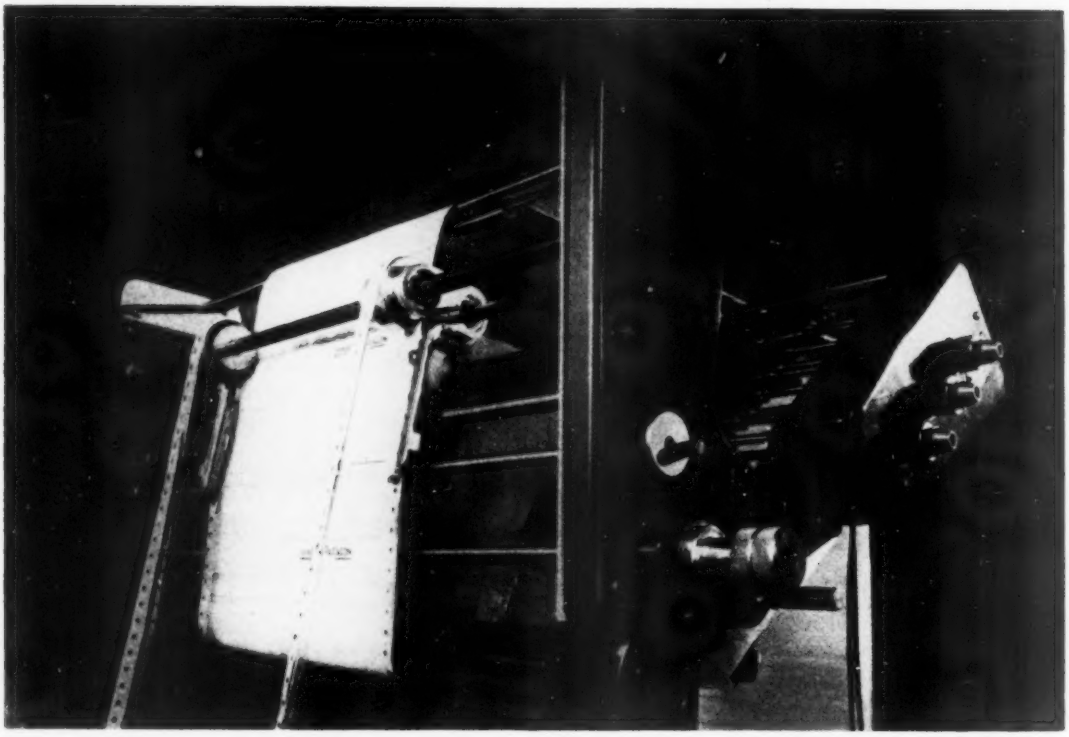
'Gan needs guns . . .' Such stock requests—2 million per month from all over the world—will soon be handled by a £600,000 AEI 1010 installation at the RAF Supply Control Centre. The computer will also maintain complete records, consumption figures, etc, for some 750,000 stock items.

Hybrid at Work

In Crawley now—in London soon

Redifon have now established a service centre at Crawley to enable their hybrid computer, which was announced in June, to undertake a 'launderette' service for scientific applications.

Their work so far has not covered data processing of a commercial nature, being largely devoted to engineering calculations, simulation and analysis. However, as the centre will shortly be transferred to London, it is anticipated that some non-engineering work will be undertaken. Hire charges for Radic vary from £12—£50 per hour.



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To discharge this responsibility the Council employs 20,000 men and women and spends about £27 million each year.

In order to provide a more comprehensive, up-to-the-minute control of their affairs, they were the first County Council in Britain to order the revolutionary new IBM 1401 solid state data processing system.

This impressive machine—of which over 70 have been ordered in Britain since it was announced in October 1959—is small, very fast and of low cost. Controlled by a stored program, it can read up to 800 punched cards a minute, while output can be as high as 600 lines of print or 250 cards punched per minute. The speed of its calculation is such that it can perform about 5000 additions *per second*.

Besides normal and arithmetical functions, the IBM 1401 has a special combination of machine features and instructions that makes data arrangement and processing quick and easy. It also has comprehensive and automatic checks on all functions, including internal data movement, input and output.

The capacity and economy of the system can be greatly increased by the addition of up to 6 magnetic tape units, each with a data transfer rate of up to 62,500 characters per second. To this can be added the IBM 1406 providing immediate access core storage beyond the basic 4,000 characters by increments of 4,000, to a maximum of 16,000 characters.

The IBM 1401 is ideal for applications where the data processing speeds of conventional punched card equipment are too low, yet where the capacity of larger computers is not warranted.

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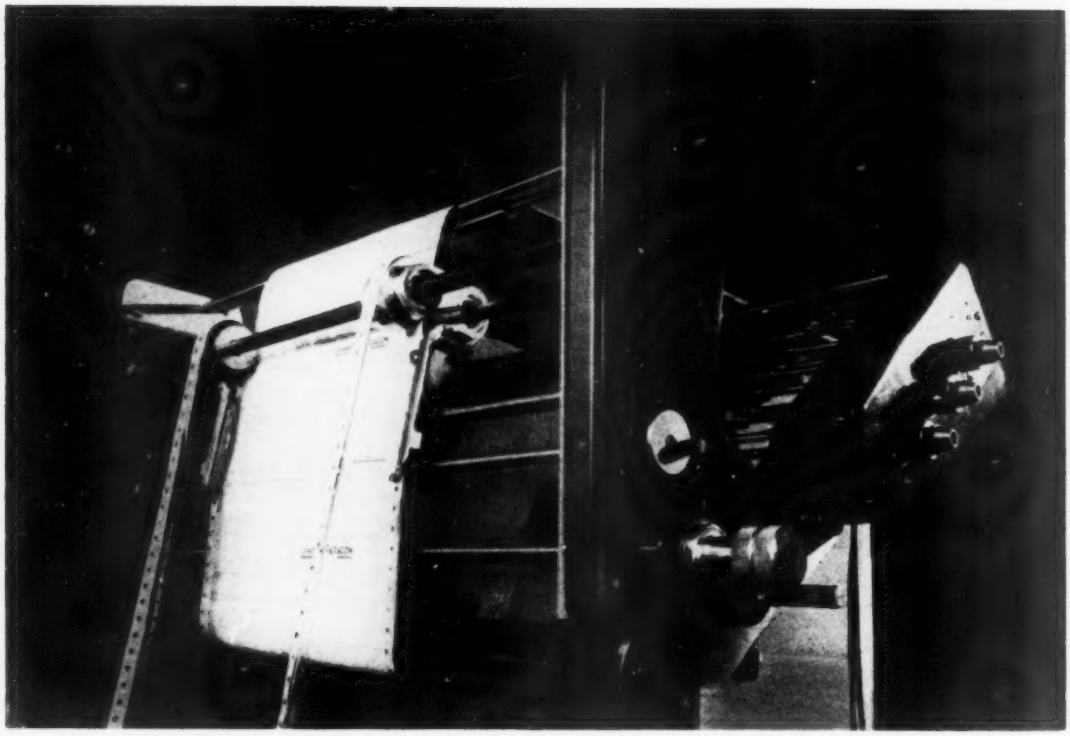

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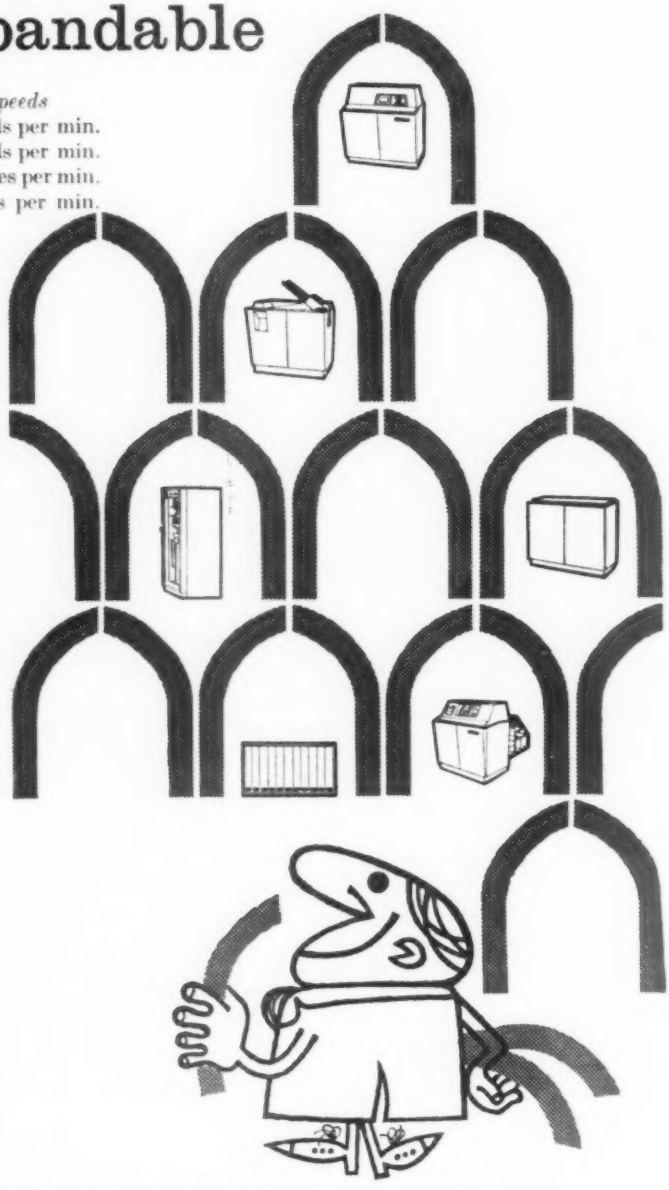

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Shell-Mex and BP's experiment with a genuine push button office to handle orders makes its bow

PUSH BUTTON OFFICE

"The most significant development of 1960"

AN industrious handmaid to its giant parents, the Shell and British Petroleum companies, Shell-Mex and BP Ltd have the function of distributing—and selling—the petroleum products refined by the parents. The company supply garages, companies and other organisations throughout Britain through some 100 sales office or depôts, which report to 10 divisional offices.

This sort of decentralisation is of course forced on the distributing organisations of the large petroleum refining companies as their products have to be delivered to the customer's door and long hauls by petrol tankers are uneconomic.

Decentralisation may bring economies, but it also means that some of the paperwork involved in handling orders, which in other organisations might be done centrally, has to be done at depôt offices.

Shell-BP have long had a strong organisation and methods section probing and examining aspects of the company's procedures and structure, and three years ago the section began to look into the clerical work performed in the depôts.

In the depôts when orders are received sales tickets are prepared, and the products despatched. Completed sales tickets, sales summaries and stock reports are then sent to the divisional offices, where punched card equipment and book-keeping machines are employed to produce sales analyses and customers' accounts, and where invoices are typed. In their quest for improvements, the O and M section, acknowledging that clerical activities in the depôts could not be avoided, looked for ways of simplifying the work without sacrificing its accuracy. Also the section's approach was that of 'modelling the beginning to ensure that it might fit into the end requirements without further manual effort'—in other words, the section wanted only a minimum of the clerical work done in the depôts to be manual and to produce results which would enable further work to be done automatically.

Ways of doing this were considered: typing information and simultaneously producing a by-product paper tape was considered impracticable as depôt clerks would then have to become typists, and accuracy could not be guaranteed by this method.

It was decided that to meet their requirements, Shell-BP would want a mechanical device to select information and build up a sales invoice that would need no checking. Details about customers should be placed in a quick-access store, details of the products in another, and by pressing buttons to select information, the invoice would be produced. Two years ago a research team produced blue-prints for such a push-button office and asked Creed and Company to build a prototype.

Buttons for 3,000

The result of this endeavour is a complex of equipment given the name DORIS (for Direct Order Recording and Invoicing System) which has been operational since July, though details of the system were only released at the end of last month.

Shell-BP stress that Doris is a prototype and that its installation at Royston in Hertfordshire, a new depôt, is in the nature of an experiment.

There are many modifications that would have to be made to successors of Doris, and their introduction into depôt offices—if the experiment is considered successful—could only be gradual.

The hub of the system is a seven-sided cubicle. A clerk sits at a horse-shoe desk and has easy access to the seven panels of push buttons, each of which bears the name and address of a customer. Altogether there are 3,000 button positions, which means that the system could accommodate 3,000 customers, though at Royston at present only 1,300 of these positions are required. In front of the clerk is an additional panel of buttons; these indicate products, quantities, days of delivery, etc.

Over 85 percent of Shell-BP's orders are taken over the telephone, and at Royston the clerk at the horse-shoe desk takes telephone orders, and sets them up on his panels. This is done by depressing the appropriate name and address, product, quantity, etc, buttons. Once an order has been set up, and an 'end of order' button depressed, *no other manual effort is required* to produce for that order a delivery note and an invoice.

All the information recorded by pressing buttons is perforated on paper tape. This punching is completed in four seconds and as the average telephone order takes at least 15 seconds there is no delay in handling orders.

This tape is read automatically to produce the documents required. This is done by first obtaining full information about the customer and product, which is stored on reels of seven-channel strengthened paper tape. For convenience in handling amendments and in order to speed processing, information about each customer has been split into static-address details and terms-of-trade details, which are stored on separate reels. 500 of these details can be held on one reel, and at Royston, which handles about 1,300 accounts, three reels are required for holding addresses and three reels for holding terms-of-trade; an extra reel holds all details relating to products.

These paper tape reels are mounted on tape decks, and the system, activated by the original paper tape punched when the buttons were depressed, seeks out the information relating to the order from three reels.

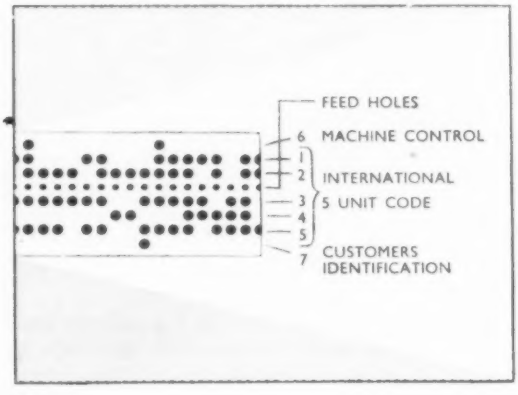
Five channels of the seven-channel tape are used for normal letters and numerals as on conventional teleprinter tape, the sixth is used for machine control codes, and the seventh to identify the customer.

Holes in the seventh channel are punched before each block of details are punched into the information tracks, and when the reader input mechanism identifies a customer number, the tape reels are revolved (at 45 feet per second) and a photoelectric cell counts the seventh channel holes until the required customer information is reached. The reels are then stopped and printing begins. The same procedure is applied to the products file reel.

With the description and price of the product printed out—sales tickets and invoices are printed simultaneously on two teleprinters—the extensions are worked out and also printed, concluding with a total.

When this operation is over, the system has produced an invoice (two copies may be made of this), and a sales ticket (again in duplicate) which is passed on to the routing clerk.

How the tracks are used on the seven-channel information storage tapes.



Control Information

At the moment when the system is printing out an invoice and a sales ticket, it is also making a permanent record of the invoice information on paper tape—to serve the accounting and statistics needs of the company. This tape is used to produce a summary of each day's transactions at the Royston depôt.

To make for simple identification of these tapes, the serial number of the sales ticket is overprinted over relevant sections of the tapes, and these sections are then held in a storage rack until the customer has received his order.

When the order has been delivered, the stored tape is brought out and fed into a *summariser*, which performs several functions:

1—It sorts the sales ticket information into a 'punched card sequence' and punches this information on to another paper tape. (This is used later in a tape-to-card converter and putting information into 'punched card sequence' means in fact rearranging certain

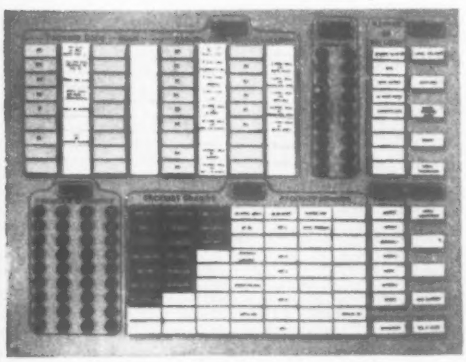
data so that these will appear across 80 columns of a punched card.)

2—It adds up the daily issues for each product. At the end of each day a printed record of the daily issues is produced together with a punched tape record (in punched card sequence) and an abbreviated tape record from which periodic stock summaries are prepared.

The Royston depôt send the detail and summary tapes, together with the printed daily summary of issues and values to the divisional office. Here tapes are fed into a tape-to-card converter to produce Hollerith cards which are employed in a punched card installation.

It would, of course, be feasible to use the paper tape output of the Doris system at the divisional office in a different manner; it might, for example, be used as the input medium for a computing system—and clearly Shell-BP had such ideas in mind when Doris was being developed.

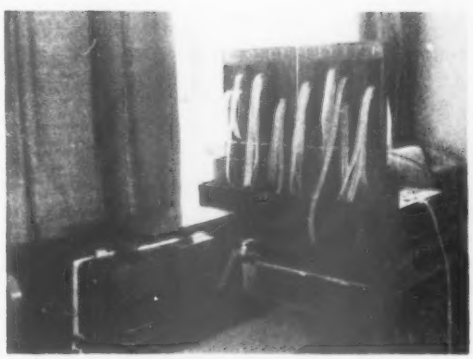
In producing blue-prints for their system, the Shell-BP research team were anxious to produce a push button office that would not cost an astronomical figure, as they envisaged that eventually they might want to establish a large number of these. Consequently, they opted for an electro-mechanical rather than an electronic system—particularly as they did not require of their automatic office ultra-high speeds of operation. As a result, although the development costs of the first Doris have been high, it is estimated that an order-handling office of this kind might cost no more than £25,000.



1 *Buttons on this panel record product, quantity, delivery day, etc.*

2 *When the sales clerk has pushed all the buttons, the basic facts are perforated on paper tape.*

3 *Reference to files produces all the information required and after extending price against quantities, invoices and sales tickets are produced simultaneously on these machines . . .*



4 *meanwhile the invoice information is punched into another tape which is stored in racks . . .*

5 *and summarised at the end of each day on this equipment.*

RESEARCH TODAY — 2

Machines like Minds?

Second of a series of two articles on the research efforts of computer manufacturers.

Keith Bean

HOW solid is the basis for the forecasts of astonishing new features in our computing systems of tomorrow, of the near future?

Advances, in this field as in others, seem to go in plateaux or steps—an upsurge of invention being followed by a plain of more straightforward development. If there is in truth such a pattern or cycle, then the strength of the forecasts for tomorrow depends largely on the phase of the cycle we have now reached.

Let us look very briefly first at the computer plateaux to date.

Computers were invented in the valve era and the early models were built with switching carried out completely by vacuum tubes, whether diode, triode or pentode. When semi-conductor point contact diodes were available a generation of machines using thermionic valves and semi-conductor diodes made its appearance. These are basically the machines of today.

Although the transistor was first announced about the same time as the first computers were starting work in universities and laboratories, the point contact transistor never really made the grade for computer use on any scale. The first transistor machines were slower than their valve counterparts.

Now the junction transistor has resulted in a new generation of machines. Modern high-speed transistor circuits are faster than any valve circuit could be. Elements recently announced by Elliotts, for example, can switch from one state to another in five millimicroseconds. They were developed from a consideration of the minimum intrinsic delay achievable taking into account the basic physics of the semi-conductor.

These techniques result in speeds as fast as those achieved in the 10-million-dollar IBM Stretch computer.

Elliotts have applied the new technique in their new machine [the 503] which will have an order code identical to the 803's but which will be able to multiply nearly a thousand times faster.

The machine (main processor, 4,000-words of main store, four high-speed magnetic tape units) will cost around £110,000. Its speed, however, means that one computer, with multiple input and output channels and using time-sharing techniques, will be able to do the work of a number of conventional computers so that, in terms of work done, computer time on a machine of this kind will be cheaper than at present.

These elements have reached about the limit that existing circuit techniques can achieve owing to the speed of light itself (186,000 miles a second), according to Mr A St Johnston, a joint general manager of Elliott Brothers.

'Since one millimicrosecond is the time it takes light to travel one foot, a five millimicrosecond rise time implies that two elements five feet apart could each think the other has switched after itself,' he says.

'So, apart from other problems, these sorts of speeds are likely to be near the end of the line for several years—a reassuring thought because in the computing world a machine is frequently obsolescent as soon as it has first been made to work.'

What then are the next likely or possible developments?

The use of microwave techniques might certainly overcome the transmission problem in the

machine and further development of the Parametron could assist in this type of system.

Reduced Enthusiasm

At one stage it looked as if the tunnel (Esaki) diode might make possible the development of circuits in conventional form operating with a one millimicrosecond rise time. However, detailed work in many laboratories has tended to reduce the initial enthusiasm and it is probably a long haul before we see machines using tunnel diodes with higher speeds than transistor machines.

Mr H Baecker of Standard Telephones and Cables, first to manufacture the tunnel diode in Europe, comments:

'The tunnel diode is the most glamorous of the new developments, and arithmetic units assembled from these components are already working in our laboratories at speeds of 10 megacycles and above. [Roughly speaking 10 megacycles represents approximately a 50 millimicrosecond rise time.] However, we feel that it is yet some years before machines based on these new components will be ready for marketing.'

The problem of physical size applies to the tunnel diode as it does the conventional transistor. This, and the need to reduce size and weight in guided missiles and satellites has led to intensive work on microminiaturisation.

Here, the eventual target is to have completely machine-made circuits, or even equipments, where individual components as such in the conventional sense do not exist. The basis may be a semi-conductor crystal into which is etched leads, resistor paths and diodes, with transistors formed by appropriate dopings.

This will bring circuit design into the hands of the component manufacturers and the system manufacturers will retreat a step nearer becoming equipment assemblers and commissioners.

If fully automatic manufacture of this kind gets under way the cost of computers—apart from input and output machines and other peripheral equipment, of course—would almost inevitably fall dramatically.

Fantastic reductions in size are also conceivable—to a thousandth of the size of present computers. Such a reduction is even now probably technically feasible, though the cost would still be vastly prohibitive.

Cryogenics

Microminiaturisation may also result in faster speeds particularly if the elements are immersed in liquid helium.

This introduces the next stage of really new techniques—cryogenics. The fundamental effect of super conductivity is employed in cryogenic

Mr A St Johnston

'Another possible series of computer elements may come from thin films of magnetic materials which consist of a single crystal domain . . . These films may be deposited in vacuo or electrolytically, and lend themselves to being etched in very fine patterns, even possibly under an electron microscope, thus resulting in complete circuits which are invisible to the human eye. This could mean the first approach to packing densities comparable to those in the human brain.'

Mr H Baecker

'The tunnel diode is the most glamorous of the new developments, and arithmetic units assembled from these components are already working at speeds of 10 megacycles and above. However . . . it is yet some years before machines based on these components will be ready for marketing.'

Mr J F Nicholson

'The increase in usefulness by making a larger and faster computer is much more than proportionate to the extra cost, the power of a computer being roughly proportional to the cube of its cost.'

elements which are used at temperatures so low that the conductors have literally zero resistance.

The conductors can be made resistive by the application of magnetic fields or by a slight increase in temperature. By this means bi-stable elements, gates and memory cells which are the basic computer 'bricks,' can be produced.

But much work remains to be done. It may take all of five years before the techniques are developed to the point where it is possible to construct the complete computing machine. The cryogenic elements themselves require to be very thin films of materials which are difficult to reproduce reliably. The problems of maintaining the very low temperatures of the liquid helium are in themselves not yet solved commercially.

'Another possible series of computer elements may come from thin films of magnetic material which consist of a single crystal domain,' suggests Elliott's Mr St Johnston. 'Much work is being done on this both in this country and the USA.

'These films may be deposited in vacuo or electrolytically and lend themselves to be etched in very fine patterns even possibly under an electron microscope, thus resulting in complete circuits which are invisible to the human eye.

'This could mean the first approach to packing densities comparable to those in the human brain.'

Smaller Giants

As to the more powerful machines, the 'giants,' Mr I F Nicholson of Ferranti sees Orion and Atlas as expressing the line of expectable development to faster more efficient machines of smaller physical size.

'Orion, fully transistorised, incorporates new logical elements based on "ballot box" logic,' he says. 'It has comprehensive time-sharing . . . Atlas is one of the fastest computers under development anywhere in the world.

'New logical design – in particular a method of fast carry propagation – has given great speed (1.1 microseconds for addition of two floating-point numbers) and the speed is in fact such that the physical size of the logical elements has to be kept as small as possible lest propagation time along the conductors should become an important factor. There is time sharing. *Store size is virtually limited only by cost.*'

Mr Nicholson foresees that very large time-sharing machines will be installed mainly at service centres, and work will be brought to the centres.

'This is common practice for technical problems, and it will probably be increasingly used for commercial data processing, chiefly on grounds of cost.

'The increase in usefulness by making a larger and faster computer is much more than proportionate to the extra cost, the power of a computer (in terms of speed and storage capacity) being roughly proportional to the square of its cost.

'This and the time-sharing by which several people can use the computer at the same time means that in many cases an organisation will get better value by doing its data processing on a large machine at a service centre than by owning a smaller machine.

'Given service centres, there is every possibility of customers being able to transmit data, perhaps directly to the computer, by means of land lines designed to handle digital information with great accuracy. The GPO is already investigating the requirements for such links.'

Mr. Nicholson foresees another aid to the general user.

'It is likely that autocodes and business languages will be used more and more in the future for the programming of computers and the use of such techniques will greatly lessen the present gap between those who are familiar with the problem to be solved and those who know how to use a computer,' he says.

'The chief problem in this field is one of finding a suitable standard language, particularly on the commercial side.'

This is a problem which is receiving active attention from the operational research section at Standard Telephones and Cables.

'Very often,' says Mr Baecker, 'the greatest hurdle to the introduction of computing techniques in commerce and industry has been the difficulty of programming a job for a computer.

'STC are well aware of the developments elsewhere aimed at circumventing this difficulty, in particular the introduction of COBOL (Common Business Orientated Language) in the USA.

'We feel that attempts so far, while perhaps giving an English language programming scheme, do not satisfy the normal English terminology applied to clerical, book-keeping procedures. Also these schemes have invariably been designed around large and expensive machines.

'STC are now developing a commercial programming language using English language words and phrases which can form a basis with which every user can simply construct more complex commands to the computer, thus incorporating in a simple manner both the technical terms and the procedures they refer to, in programming his operations.

'Additionally, the simple, even unambitious, structure of the basic language allows it and its more complex derivatives to be used efficiently and economically on smaller and low-priced data processing systems.'

From Manual Methods To Electronics — in one hop

When sales leapt up, the old systems had to be shed quickly if the company wanted to see cash in its coffers and sales figures in the boardroom.

OBSERVANT executives who are periodically startled to find their secretaries' hair has changed colour realise that, in this age of the office-girl affluence, the ladies' preparations and cosmetics market is very bullish. Sitting comfortably on top of this boom is one London West End Company, XYZ Ltd.* who manufacture a range of dyes, bleaches, rinses and other preparations to transform the modern miss.

During the last four years XYZ's sales have rocketed and the company have expanded. An indication of this expansion is gleaned when one compares the number of accounts the company had four years ago with today's number: in 1956 the company traded through 2,500 accounts; at present they have well over six times that number.

The key to this success was a change in marketing policy. Until 1956 the company traded mostly through wholesalers, but in that year the board decided that additionally the company's products should be sold direct to retailers—in particular retail chemists and hairdressers. Two sales forces were recruited to cover the two kinds of retail outlets throughout Britain. Result: a vastly increased turnover.

However, XYZ's success left at least one problem in its wake: it put a strain on the paperwork organisation. First, there were many more orders to handle and process, and invoices and statements to prepare: and secondly, the task of producing information for management—breakdowns of sales and revenue—was made more difficult with the increased number of documents to handle. The ability to send out invoices quickly is, of course, crucial to any company—a steady flow of cash depends on this—but up-to-date sales figures were also essential: XYZ supply from stock and rely on sales figures for deciding on future production.

Previously, the company's paperwork methods were mostly manual. Keeping track of sales, for example, was done by manually sorting invoices no less than eight times in order to obtain sales figures, by product, by outlet, etc.—batch totals being entered in sales day books, which then became the source for producing monthly sales summaries and customers' statements.

Inevitably, new mechanised methods became essential when the number of accounts and the sales made began to swell. XYZ's solution to the paperwork problem has in fact taken two forms: to

* Fictitious Name. This article, nevertheless, refers to the systems of a real company.

One of the Sensimatic book-keeping machines used in the new set-up, and (right) the tape punch where sales data is 'captured'.

produce invoices, statements and ledger accounts the company have introduced into their offices new equipment and methods, while 'management information' is prepared for the company at a computer centre.

These two sets of clerical tasks are of course linked, and this is best explained by following through what happens when an order arrives.

Orders from retail establishments are received by phone, or through the mails direct or via representatives in the field, while those from wholesalers are either mailed or phoned.

These are written out by hand on order forms which go to a team of nine typists which prepares five-part invoice sets (six-part in the case of retail customers) on typewriters. On the invoice sets, at this stage, are printed the names and addresses of customers, representatives' code numbers, customer reference numbers, the quantity of each of the products required, the description and price of each product, and relevant product codes.

Copies of the invoices are then distributed as follows: three copies are routed to the company's factory outside London in Buckinghamshire, while two (or three in the case of retail orders) are filed away at headquarters temporarily.

The three copies that arrive at the factory are used as follows: one copy of the invoices accompanies the goods, one is kept by the factory and the remaining copy is returned to London with carriage charges for goods despatched entered on it.

When head office in London receives the factory copy the prices and quantities are extended; this is done by three operators using Burroughs Duplex calculators, and the values are then entered *by hand* on the factory copy of the invoice.

At this stage the two (or three) office copies of the invoice are taken out of the files in order to prepare from the factory copy the invoice that will be sent to the customer. For this XYZ use four Burroughs' Sensimatic book-keeping machines. *These are each fitted with a paper tape punch and it is these machines which provide the link between the order handling and billing tasks, and the provision of information for the company's management.*

Office copies of an invoice set are put into a Sensimatic and the operator keys in, copying not only the information on the products ordered, but also the extensions previously calculated and code numbers, such as the customer's account number and the representative's number. This is done in order that the book-keeping machine may do a 'check figures' proof before printing anything out. This proofing operation ensures that the invoice is accurate.

The book-keeping machines, which represent an investment of about £12,000 (a Sensimatic of this kind costs about £3,000), perform four operations:

1. they complete customers' invoices: they print out extensions and totals.
2. they print out statements.
3. they make entries on ledger cards. (Operations 2 and 3 are done at the same time and the operator prepares a statement and makes ledger entries immediately after completing an invoice.
4. they punch a paper tape on which is recorded the type of product sold, the quantities.

Daily, XYZ despatch these paper tape records to Ferranti's computer centre in Portland Place, where they are processed.

For their £12,000 investment the company estimated they have a system which can handle an average of 400 invoices a day and the associated ledger and statement work, and which in addition produces a record of sales in a computer medium—paper tape. The company admit that seasonal peaks in trade (at Easter and in the late summer) do produce days when more than 400 invoices need to be handled, but by arranging for relief operators to work throughout the luncheon

breaks, they cope during these freak periods.

With offices in central London, XYZ find that one of their problems is a shortage of space, and this was one of the factors that influenced the management when they were considering new systems for billing customers and doing sales analyses.

Having their sales analyses 'done outside' certainly means that the company have not had to squeeze a great deal more equipment into already full offices, and probably this was one reason why they decided not to adopt punched card equipment, when expansion made new methods a necessity.

The company pay Ferranti £50 an hour for computer time and at the centre it takes some seven to ten hours to process, analyse, etc. some 80,000 entries—this is the monthly average: XYZ put out about 10,000 invoices a month and each will have about eight lines. However, it is estimated that a 100-percent increase in the number of entries would require no more than one third more computer time; thus, 100,000 entries a month could be processed for £500.

The computer run and the programs developed for the company are detailed in the box on this page. The results of this service can, however, be briefly summarised here. From the centre the company receive:

1—Main Sales Analyses (analyses by main products).

2—Representatives' commission returns (the commission owed to each salesman).

3—A monthly summary of sales.

The first company in Britain to use bookkeeping machines linked to tape punches for invoicing work, XYZ, by pioneering in this way, have jumped from manual to electronic methods in one hop, and yet devised practical and economic systems.

SERVICE CENTRE RUNS

Each day, the tapes produced by XYZ Ltd on their Burrough's Sensimatic machines are sent to Ferranti's computing centre in Portland Place, London, to be processed on Pegasus and Sirius computers. It would be possible for the whole process to be done on the Pegasus computer but it was decided to do tape checking on the smaller transistorised Sirius computer as it is less expensive to hire time on this machine.

Sirius checks that the Sensimatic has been punching the tapes properly by finding out if each invoice or credit note contains all the required information, such as the invoice number, the class of customer, the representative who sold the merchandise, whether it was a direct or indirect sale, the product number, quantity and value for each sale, and a check sum. After a number of invoices, a batch total is punched. This is the sterling value of all the invoices punched on the tape since the last batch total. If this agrees with the total calculated by the computer then it is known that every invoice item has been correctly punched.

As well as checking the mechanical and electrical efficiency of the Sensimatic machine, the Sirius computer makes sure that there has been no human error made by the machine operator or the invoice clerk. Every product code used is checked to see that it is in current use and its price, which is stored independently inside the computer, is multiplied by the quantity given on the tape to make sure that the extension has been correctly entered. Any errors which have been made are then recorded automatically by the Sirius computer and the offending invoices are erased from the tape, so that XYZ Ltd can repunch corrected invoices. When this checking is completed the tape is known to be absolutely correct in every detail and can be used to obtain an accurate analysis of the monthly transactions.

The rest of the operations are carried out on the centre's Pegasus which is equipped with magnetic tape storage facilities. Magnetic tape is read many times more quickly than paper tape by the Pegasus computer, and so the information is transferred from paper tape to magnetic tape once a week. The information for each month is kept on a separate magnetic tape which is then stored indefinitely and can be referred to a long time after it has been recorded.

When all the invoices for the current month have been transferred to magnetic tape the monthly analysis of the figures begins. XYZ require two types of analysis for them, the first showing the quantity and value of groups of products sold to different classes of customers, for example to retail chemists or to wholesale hairdressers, and the second showing the value of groups of products sold by each representative. This latter analysis gives the figures on which they base the payment of commission to their representatives.

Pegasus calculates the required figure for both analyses in three hours whereas previously these took XYZ a number of days to produce with desk calculating machines.

Now that these two analyses have been running successfully for some months, the centre has been asked to do another analysis to compare sales to wholesalers each quarter. This is the beginning of a system which will ensure easy access to sales figures and will enable the sales department to plan sales campaigns much more efficiently than was ever possible before.

AMERICAN REPORT from John Diebold and Associates, New York

Taking stock of computer languages

How and why machine languages have been and are being created.

Ever since the introduction of computers, various programming methods have been developed which use the computer itself for simplifying the chore of preparing problem-solving codes for the computer. The early programs for this purpose were developed by each installation as the need arose. Today, such programs are extremely complex and the major programming aids are being prepared by computer manufacturers as an essential service which is demanded by the customer. This, then, is the moment to take stock of the significant developments in the creation of computer languages and to try and point out the influence of these developments on the structure of newer languages.

Before 1951, programs for computers were prepared in the actual machine language. Code sheets were written with one instruction per line, the location of the instruction being indicated on the line. After key punching on cards, paper or magnetic tape, the instructions were entered by a loader into memory. The difficulties of preparing codes in this manner were so great, however, that before the first commercial computers —the Remington Rand Univac I and the IBM 701—were placed in installations, relative codes were devised for program preparation.

Relative coding is very similar to machine coding except that all addresses are designated by a field symbol and a relative increment. A relative loader, given absolute locations for field symbols, formed absolute addresses and locations for instructions, and loaded them into memory. This permitted routines to be located at any point in memory so that a sub-routine library became possible and the organisation of large problems was facilitated.

The next major advance in language development was the introduction of symbolic assembly programs. These programs preserved the natural form of a computer instruction but particular locations and all operation codes were designated by arbitrary nmemonic names or symbols. A compiler used for symbolic assembly formed a table of symbols and by counting, determined absolute locations for these. The operating code list was amplified by pseudo-codes which operated upon the compiler. The compiler with limited direction via pseudo-codes from the programmer did most of the book-keeping in assembling codes for large programs. The compiler was also furnished with the ability to automatically insert sub-routines from a library tape on tape computers. Sub-routines were normally written in the symbolic assembly language, then relativised with respect to their call symbol by a modification of the standard assembly program. These features, which were first embodied in SAP (Share Assembly Program) for the IBM 704, made it possible to organise very large programs and have greatly influenced other machine oriented language structures.

Now, every large-scale computer which is introduced has a basic symbolic assembly program written for it, though, of course, new features are gradually being incorporated into these programs. Principal among these are:

1. The ability to correct code in source language.

Early assembly programs required that minor corrections be made in actual machine language. Source language corrections required that corrections be merged with the original program list and the program be re-compiled and assembled. Several of the newer programs retain the original compiler list. This is modified by corrections which are then inserted during assembly. Such a procedure saves a great deal of machine time, makes it unnecessary for the programmer to learn two languages (source and object) and facilitates testing, since special instructions to display information at a particular time can easily be inserted.

2. Ability to insert macros. An early concept of macros considered that a set of parameters specified on an instruction line was inserted into a fixed code pattern. This was broadened to permit insertion into one of a number of coding patterns as determined by the parameters. Today a macro can mean a complete translator in which algebraic statements are translated into machine language. It is possible to include translators for business problems, algebraic problems using point variables, matrix problems and others. Current assembly programs, however, do not possess more than one type of translator.

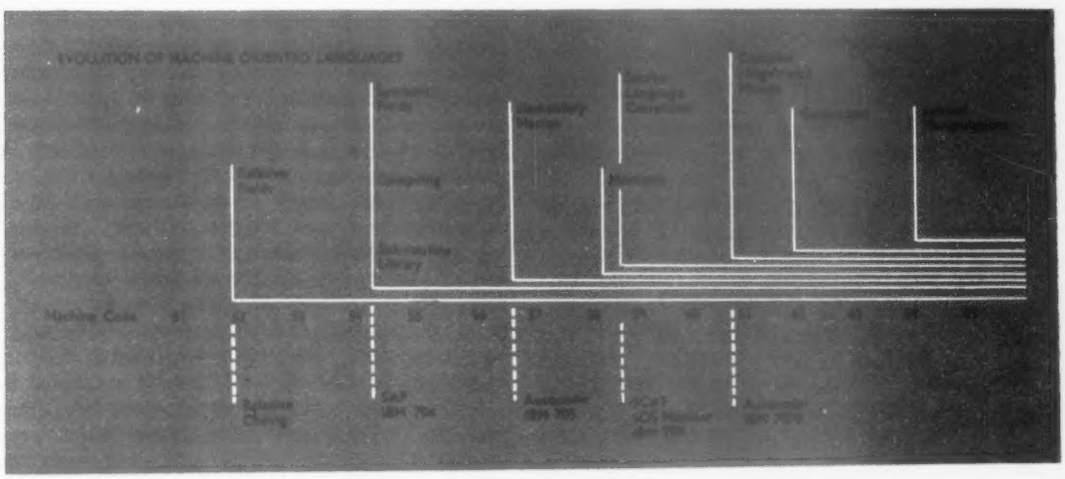
Problem Oriented Languages

At present most of the discussion concerning computer languages is devoted to the problem oriented languages. The first well-known language of this type was FORTRAN (FORmula TRANSlator) which was first used in 1957 for coding the IBM 704. Fortran was designed to solve scientific problems. It was soon followed by FLOW-MATIC to solve business problems on Remington Rand Univac I and II in 1958. Currently, there are at least 30 problem oriented languages for various computers. However, despite this growth in number the basic characteristics of the two original languages have been retained.

The scientific languages are designed to solve algebraic equations which use as variables floating point, single precision real numbers. They are also able to solve equations using integers, the integer arithmatic being used primarily to set indices for subscripted variables. Some of the newer languages also include the ability to test symbols with the Boolean 'AND' and 'OR' operators. The operations using variables include the ability to repeat sequences of equations, varying subscripts as specified by the programmer, and to make logical decisions based on tests of variable or subscript values. Sub-routines such as the elementary functions may be named in statements and are incorporated into the object program. Restricted forms which are sufficiently general for most engineering purposes are used for input and output.

The business languages assume that the basic items dealt with are fields from records. Record layouts are specified and read prior to problem statements. During translation, reference is made to the record layout in order to deduce the proper coding for field extraction, manipulation and insertion. Other features of the business languages are similar to those of the engineering languages except that they usually permit longer symbolic names and statements with redundant English phrases to clarify the content.

Problem oriented language statements are read,



then names, operational symbols such as + − / = and phrase symbols such as . , ( ) are extracted and the translator interprets the meaning and generates a machine code. The compiler lists information and counts, locating all instructions and data according to a prescribed assignment procedure. Some languages possess equivalence and frequency statements to aid the assignment algorithm. At this point, the final code may be assembled by an assembly program.

Soon after the first problem oriented languages were tested and found to be operative, it seemed possible to specify universal languages which could operate on any computer, regardless of its special features, and which would provide a standard method of communicating with a computer. Committees were formed in Europe and in the USA which have specified two languages, ALGOL (ALGOrithm Language) and COBOL (Commercial Business Oriented Language).

A preliminary set of specifications for ALGOL were published in 1958 and a revised and more authoritative version appeared in May, 1960. To date several preliminary versions of ALGOL have been programmed, others are on the way. These include CLIP (System Development Corporation), MAD (University of Michigan), NELIAC (Naval Electronics Laboratory), CORREGATE (Carnegie Technical Institute), 222 ALGOL (Burroughs Corporation) and others.

A set of initial specifications to COBOL were printed in April, 1960, and supplements to these specifications are now being released. The RCA Corporation has announced that a version of COBOL for the RCA 501 will be ready for field use by October, 1960. Other companies indicate that they will have versions of COBOL but have not stated dates for these programs.

Despite the intense interest and large amount of work on the problem oriented languages, the working programs completed up to this time have many poor features. These are:

1. The languages are difficult to expand. It is extremely difficult to add new statement tapes to problem oriented languages and this is usually not done except by the original coding group.
2. They are difficult to use for partial coding of problems not in the range of the language. Problem oriented languages are limited to coding very restricted classes of problems but for certain problems it is desirable to use both such a language and a symbolic machine code. This is hard to do since it is necessary to know the assignment algorithm of the problem oriented language to join the two codes.
3. They use large amounts of machine time for compilation. Many do not contain source language correction features and this makes it necessary to compile many times if source language program corrections are used or it is necessary to use programmers with sufficient experience to make machine language corrections. The COBOL specifications recommend that implementers include the functions of *insertion*, *replacement* and *deletion* for entire lines. ALGOL specifications do not mention this.

COBOL specifications recognise that programs cannot be written independent of a machine at present. The form of a tape record for business purposes depends for example on the computer memory structure. The record layout for computers designed to handle characters and fields will be different from the layout of records processed in computers using words as the basic unit of information. Again, identical scientific problem specifications will result in different solutions on different computer types because of design variations. Results obtained from computers which use a 48-bit word will not agree with results on computers using a 36-bit word with present ALGOL specifications.

Another disadvantage of problem oriented languages is that the common use of these in an installation narrows the vision of the users. Using such a language as a standard restricts the application possibilities by ignoring the full potential of the actual computer, which itself is not bound by a restricted language.

Due to the restricted application of present problem oriented languages it is probable that their use as closed languages will be discontinued in the near future. Inclusion of the problem oriented language function as a macro in a symbolic assembly program makes a much more powerful problem-solving tool.

Generators

Generators are programs which write machine code and select and assemble sub-routines into an object code for performing complex, but well-defined, procedures. Well-designed generators are data and environment oriented. A well-known type of generator is the sort generator. Such a generator must extract fields for comparison purposes (it writes a code to do this sometimes rearranging the record for this purpose); it must use the maximum amount of storage available for sorting and it must use the maximum number of tapes which are available (thus the merge program is variable) and it must be prepared to handle single, blocked and variable length records as well as various tape label records.

Some of the later problem oriented languages and the symbolic assembly programs include generators for input-output programs. Com-

plete generative languages have been written to solve business problems. These are composed of three distinct generators, a sort generator, a file maintenance generator and a report generator. The two latest are 9 PAC and SURGE, both prepared by SHARE committee. These generators have the same faults as many of the problem oriented languages: they are closed systems so that it is difficult to expand the language; codes cannot be joined easily to machine language codes, and changes in the source language require recompiling.

Thus, due to these restrictions, it is probable that the generators as closed languages will also be discontinued in the future. But, the use of generators can also be an extremely powerful tool for the solution of scientific and operations research problems. Many of the basic mathematical techniques which form the core of a problem solution are functionally well defined but require complex data and environment oriented programs for computer processing. For example the matrix equation $A \cdot X = B$ requires a set of routines for efficient computer solution. These are selected according to the size and conditioning of the A matrix. The first procedure selected may not work, thus another must be tried. Generators for linear algebraic equations, non-linear algebraic equations and for ordinary differential equations as well as for other widely used and well-defined mathematical techniques can be devised. Such generators would contain the experience of many numerical analysts and would make it possible to cut the program effort in half in many scientific computing installations if used with symbol assembly programs and algebraic macros.

Symbol Manipulative Languages

Symbol manipulative languages are designed to solve problems which use heuristic techniques (adaptive, cut and try methods characteristic of human behaviour), and to solve other formally defined problems to obtain results which are symbols rather than numbers. Specifically, some problems these languages attempt to solve are:

1. Theorem proving in formal areas.
2. Chess playing.
3. Writing compilers to express the language itself in machine code.
4. Writing programs for formal differentiation, integration and simplification.

Several languages of this type are in various stages of development at this time. These include the IPL (INFORMATION PROCESSING LANGUAGE) series of languages IPL I, II . . . . , VI. [See for the LISP (LIST PROCESSOR.)] The IPL languages have already been used for problems theorem proving and chess (see above) and in certain other areas.

These languages at present lie outside the main stream of language development for routine problem solving. It is anticipated that in two or three years the properties will be sufficiently well developed so that they can be used to write compilers and translators for machine oriented languages and will enrich such languages by the ability to handle formal algebraic manipulation. These languages will also provide the base for a second main stream of program language development.

Main Streams of Language Development

Despite the current development of many closed problem oriented languages, including the business generators, the restrictions imposed on computer usage by the language limitations indicate that the future development of such languages lies in their incorporation as specialised translators in symbolic machine assembly programs. In this manner the full ability of the computer can be applied to any problem but coding can be greatly simplified by the insertion of problem oriented languages as translators, and by the insertion of appropriate generators, which will yield at the outset a problem-solving capability not possessed by current systems. The problem-solving ability can be further improved by adding techniques for algebraic manipulation which are being explored today in the symbol manipulative languages.

Thus, by 1964 coding for computers although based upon machine coding principles will bear only a faint resemblance to the base language and most programmers will not use machine code at all. Programs will still, however, be humanly organised by specific directions from programmers on selection of the actual problem-solving procedures and the order of their use.

A second main stream of program development can be started by improvements in symbol manipulative languages. Specifically, the second main stream will occur with the preparation of self-organising programs. In this concept, problem-solving techniques are read by the computer in algebraic-like notation with general directions on when to apply them. The computer under direction of a self-organising program will prepare the necessary machine codes for applying the procedure to solve problems and the directions for calling the procedure. The implementation of such a procedure appears to be possible within the next decade.

It is unlikely that this type of programming can be applied to current medium- and large-scale computers. Larger memories and the ability to handle numerous simultaneous operations are needed. Present computers and computers of the future with comparable capacities must use programs organised for machine oriented programs.

Large and Medium Size Computers

Pegasus 1—(Maker—Ferranti Ltd)
Size: Medium. *Price:* £50,000 to £150,000.
Applications: Chiefly scientific and technical; can be used for commercial data processing by adding magnetic tape converter.
Delivery: Six months.

Pegasus 2
Size: Medium. *Price:* £60,000 to £200,000.
Applications: Commercial data processing problems of all kinds. Scientific and technical work.
Delivery: Six months.

SINCE Pegasus 2 is a development from Pegasus 1, it is convenient to group the two together. From the commercial user's viewpoint chief difference between the two can be summed up as follows.

Pegasus 1 is built chiefly for scientific and technical work. It can, however, by means of a converter, be applied to commercial data processing. Pegasus 2 is designed *specifically* for commercial work, though it can also be applied to scientific and technical problems.

Thus, a commercial user today, intending to buy a Pegasus, would almost certainly choose a 2. But the same type of businessman already employing a Pegasus 1 for technical jobs could enlarge the scope of his computer by adding the converter.

Pegasus 1 in its basic form uses punched paper tape input and output, print-out being achieved by placing output tape in a Flexowriter, teleprinter or other relatively slow character printer. The magnetic tape converter permits use of punched card input and an output of punched cards and high-speed printer. The punched card equipment can be used in addition, or as an alternative, to punched paper tape and can therefore be added after initial installation.

Pegasus 2 forms the centre of three different commercial data processing systems. The first, known as the converter system, can turn out a high volume of work because the converter and ancillary magnetic tape equipment ensures that all units in the system work at optimum capacity. Also, the converter can operate off-line. This allows it to prepare the computer's next task while the current one is in progress.

In the second system, known as 'direct', information on various makes of punched cards can be fed directly into or produced by the computer. This facility is particularly useful for users of existing punched card installations.

The third method used by Pegasus 2 is known as the 'common language' system. This is based on the use of perforated paper tape, and is thus particularly suitable for organisations with scattered offices. Tape, perforated as a by-product of ordinary office machines, can easily be transmitted by telegraph wire or sent by mail.

An extensive program library is available for users of both machines; further useful data are available through an exchange scheme between users.

SPECIFICATIONS—**Pegasus 1**

Arithmetic Speeds:
Addition & Subtraction: 0.3 milliseconds.
Multiplication: 2 milliseconds.
Division: 5.5 milliseconds.

Internal Storage:
Single-word nickel delay lines with immediate access. 48 x 39-bit storage registers and 7 accumulators.
Magnetic drum. 4,096 or 7,168 x 39-bit words. Access time per 8-word block, 17 milliseconds maximum, 9 milliseconds average.

Input/Output External Storage:
Input: Punched tape reader. 200 or 300 characters per second, according to model.
Punched card reader: 200 x 80-column cards per minute.
Output: (used with magnetic tape converter)
Paper tape punch. 33 or 300 characters per second, according to model.
Card punch. 100 x 80-column cards per minute.
Line printer. 150 x 90-character lines per minute (minimum speed).
Teleprinter (working from tape punch): 10 characters per second.
Storage: Up to 5 magnetic tape units with control unit. Multiple lengths of 600 feet to maximum of 3,000 feet per reel. Full reel takes 175,000 to 270,000 x 11-decimal-digit words (2,000,000 alpha-numeric characters). Search time 24 x 16-word sections or 19 x 32-word sections per second. Read-write time 41-53 milliseconds. Rewind time for full length 4 minutes. Width $\frac{1}{4}$ inch.
Buffer has 32 x 39-binary-digit words. Can be used in 2 x 16-word sections. Tape-buffer transfer time 1.25 milliseconds.

Maximum number of input output units: Tape system: 2 readers, 6 punches. Card system: 1 reader, 1 punch, 1 printer.

SPECIFICATIONS—**Pegasus 2**

Arithmetic Speeds:
Addition & Subtraction: 0.3 milliseconds.
Multiplication: 2 milliseconds.
Division: 5.5 milliseconds.

Internal Storage:
Single-word nickel delay lines, with immediate access. 48 x 39-binary-digit storage registers and 7 accumulators.
8-word nickel delay lines, access time about 1 millisecond. 128 or 256 x 39-binary-digit words.
Magnetic drum. 7,040 x 39-bit words. Access time per 8-word block, 17 milliseconds maximum, 9 milliseconds average.
Input/Output External Storage:
Input: Punched card reader. 200 x 65-column or 80-column or 120 x 80-column cards per minute, according to model. May be used with magnetic tape converter.
Punched tape reader. 300 characters per second.
Output: Card punch 100 x 65- or 80-column or 120 x 80-column cards per minute, according to model.
Paper tape punch. 60 or 300 characters per second, according to model.
Line printer. 150 x 102-character lines or 100 x 100-character lines per minute, according to model. (Card and line printer output may or on-line or from magnetic tape converter).
Teleprinter (working from paper tape). 10 characters per second.
Storage: Up to 5 magnetic tape units with control unit. Multiple lengths of 600 feet with maximum 3,000 feet per reel. Full reel takes 175,000 to 270,000 x 39-binary-digit words (2,000,000 alpha numeric characters). Search-time. 24 x 16-word or 19 x 32-word sections per second. Read-write time 41-53 milliseconds. Rewind time 4 minutes for full length.
Buffer has 32 x 39-binary-digit words; can be used in 2 x 16-word sections. Tape-buffer transfer 41-53 milliseconds. 8-word buffer-main store transfer 1.25 milliseconds.
Maximum number of input output units: Paper Tape system: 2 tape readers, 6 punches. Card system: 2 readers, 2 punches, 2 printers.

MERCURY—(Maker—Ferranti Ltd)
Size: Medium. *Price:* About £110,000.
Applications: Science, technology and industrial mathematics—*eg.* computing trajectories, matrix algebra, X-ray and stress analysis, simultaneous or partial differential equations, linear programming.
Delivery: About 12 months.

THE makers of Mercury emphasise that, though completely versatile, the computer is essentially intended for technical and scientific calculations. The machine is powerful, fast, has a large storage capacity and facilities for the most advanced programming techniques. An autocode program procedure is available.

Mercury carries out all arithmetical operations directly on numbers represented in 'floating point' form. It has two main storage systems—a large, immediate access ferrite core (computing store) and a high-capacity magnetic drum backing store. In addition, where required, from two to eight magnetic tape mechanisms may be used.

Seven special 'B' registers are provided, each storing an integer equivalent to about three decimal digits. These 'modify' the address of storage registers referred to by any floating point arithmetical instructions and hold counters which determine the number of times a repetitive process is carried out.

Input may be by punched paper tape or cards. Output is through normal or high-speed paper tape punch, card punch and on- or off-line printer. Graphical output, that is, automatic plotting of results, may be obtained by using equipment actuated by punched paper tape. This plots up to nine curves simultaneously using different plotting symbols; has a speed of 30 points per minute.

Mercury comprises a power supply unit, two magnetic drum trolleys, control desk, and three other units in which the remaining equipment is housed. These three are respectively 15 feet 2 inches, 10 feet 10 inches and 4 feet 4 inches in length. The whole installation (except the power supply unit and magnetic drum trolleys) is cooled by a separately powered air circulation system.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 180 microseconds.
Multiplication: 300 microseconds.
Division: Programmed.
Organisation: 60 microseconds.
Internal Storage:
Immediate access magnetic core. 4,096 words of 10 binary digits each. Access time 10 microseconds (included in arithmetic speeds given above).
Input Output External Storage:
Input: Paper tape reader for 5-channel tape. Speed 200 or 300 characters per second.
Punched card reader. 200 x 80-column cards per minute.
Output: Paper tape punch. 33, 60 or 300 characters per second according to model.
Card punch. 100 x 80-column cards per minute.
Line printer. At least 150 lines per minute.
Teleprinter (actuated by output paper tape). 7 or 10 characters per second.

Graphical output. 30 points per minute, 9 curves simultaneously.
Storage: 2 (or 4 half-capacity) magnetic drums. Total capacity, 16,384 floating-point numbers. Revolution time, 17 milliseconds. Transfer time, 7.5 milliseconds for 32-word block.
Up to 8 magnetic tape units with control unit for each group of 4. Transfer and search initiation time, 120 microseconds. Running speed, 60 inches per second. Tape dimensions: ½ inch wide, 3,000 feet long. Capacity per spool, about 1,250,000 alpha-numeric characters (200,000 words) or 640,000 words, according to size of information blocks.
Maximum number of input output units: 8 paper tape input/output units and card equipments. Up to 8 tape decks.

ORION—(Maker—Ferranti Ltd)
Size: Medium—Large. *Price:* £120,000 to £300,000.
Applications: Large and medium scale commercial data processing systems of various kinds; all forms of technical and commercial computing.
Delivery: First production model about September 1961.

DESIGN of Orion is based on 'neuron' logical elements which proved successful in Sirius—a method which permits building up of complex systems with a minimum of components. The purchaser can begin with a small nucleus and gradually enlarge

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Pegasus 2 forms the centre of three different commercial data processing systems. The first, known as the converter system, can turn out a high volume of work because the converter and ancillary magnetic tape equipment ensures that all units in the system work at optimum capacity. Also, the converter can operate off-line. This allows it to prepare the computer's next task while the current one is in progress.

In the second system, known as 'direct', information on various makes of punched cards can be fed directly into or produced by the computer. This facility is particularly useful for users of existing punched card installations.

The third method used by Pegasus 2 is known as the 'common language' system. This is based on the use of perforated paper tape, and is thus particularly suitable for organisations with scattered offices. Tape, perforated as a by-product of ordinary office machines, can easily be transmitted by telegraph wire or sent by mail.

An extensive program library is available for users of both machines; further useful data are available through an exchange scheme between users.

SPECIFICATIONS—**Pegasus 1**

Arithmetic Speeds:
Addition & Subtraction: 0.3 milliseconds.
Multiplication: 2 milliseconds.
Division: 5.5 milliseconds.

Internal Storage:
Single-word nickel delay lines with immediate access 48 x 39-bit storage registers and 7 accumulators.
Magnetic drum: 4,096 or 7,168 x 39-bit words. Access time per 8-word block, 17 milliseconds maximum, 9 milliseconds average.

Input/Output/External Storage:
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Buffer has 32 x 39-binary-digit words. Can be used in 2 x 16-word sections. Tape-buffer transfer time 1.25 milliseconds.
Maximum number of input/output units: Tape system: 2 readers, 6 punches. Card system: 1 reader, 1 punch, 1 printer.

SPECIFICATIONS—**Pegasus 2**

Arithmetic Speeds:
Addition & Subtraction: 0.3 milliseconds.
Multiplication: 2 milliseconds.
Division: 5.5 milliseconds.

Internal Storage:
Single-word nickel delay lines, with immediate access. 48 x 39-binary-digit storage registers and 7 accumulators.
8-word nickel delay lines, access time about 1 millisecond. 128 or 256 x 39-binary-digit words.
Magnetic drum. 7,040 x 39-bit words. Access time per 8-word block, 17 milliseconds maximum, 9 milliseconds average.
Input/Output/External Storage:
Input: Punched card reader. 200 x 65- or 80-column or 80-column or 120 x 80-column cards per minute, according to model. May be used with magnetic tape converter.
Punched tape reader. 300 characters per second.
Output: Card punch 100 x 65- or 80-column or 120 x 80-column cards per minute, according to model.
Paper tape punch. 60 or 300 characters per second, according to model.
Line printer. 150 x 102-character lines or 100 x 100-character lines per minute, according to model. (Card and line printer output may or on-line or from magnetic tape converter).
Teleprinter (working from paper tape). 10 characters per second.
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Applications: Science, technology and industrial mathematics *eg.* computing trajectories, matrix algebra, X-ray and stress analysis, simultaneous or partial differential equations, linear programming.
Delivery: About 12 months.

THE makers of Mercury emphasise that, though completely versatile, the computer is essentially intended for technical and scientific calculations. The machine is powerful, fast, has a large storage capacity and facilities for the most advanced programming techniques. An autocode program procedure is available.

Mercury carries out all arithmetical operations directly on numbers represented in 'floating point' form. It has two main storage systems—a large, immediate access ferrite core (computing store) and a high-capacity magnetic drum backing store. In addition, where required, from two to eight magnetic tape mechanisms may be used.

Seven special 'B' registers are provided, each storing an integer equivalent to about three decimal digits. These 'modify' the address of storage registers referred to by any floating point arithmetical instructions and hold counters which determine the number of times a repetitive process is carried out.

Input may be by punched paper tape or cards. Output is through normal or high-speed paper tape punch, card punch and on- or off-line printer. Graphical output, that is, automatic plotting of results, may be obtained by using equipment actuated by punched paper tape. This plots up to nine curves simultaneously using different plotting symbols; has a speed of 30 points per minute.

Mercury comprises a power supply unit, two magnetic drum trolleys, control desk, and three other units in which the remaining equipment is housed. These three are respectively 15 feet 2 inches, 10 feet 10 inches and 4 feet 4 inches in length. The whole installation (except the power supply unit and magnetic drum trolleys) is cooled by a separately powered air circulation system.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 180 microseconds.
Multiplication: 300 microseconds.
Division: Programmed.
Organisation: 60 microseconds.
Internal Storage:
Immediate access magnetic core. 4,096 words of 10 binary digits each. Access time 10 microseconds (included in arithmetic speeds given above).
Input/Output/External Storage:
Input: Paper tape reader for 5-channel tape. Speed 200 or 300 characters per second.
Punched card reader. 200 x 80-column cards per minute.
Output: Paper tape punch. 33, 60 or 300 characters per second according to model.
Card punch. 100 x 80-column cards per minute.
Line printer. At least 150 lines per minute.
Teleprinter (actuated by output paper tape). 7 or 10 characters per second.

Graphical output. 30 points per minute, 9 curves simultaneously.
Storage: 2 (or 4 half-capacity) magnetic drums. Total capacity, 16,384 floating-point numbers. Revolution time, 17 milliseconds. Transfer time, 7.5 milliseconds for 32-word block.
Up to 8 magnetic tape units with control unit for each group of 4. Transfer and search initiation time, 120 microseconds. Running speed, 60 inches per second. Tape dimensions: ½ inch wide, 3,000 feet long. Capacity per spool, about 1,250,000 alpha-numeric characters (200,000 words) or 640,000 words, according to size of information blocks.
Maximum number of input/output units: 8 paper tape input/output units and card equipments. Up to 8 tape decks.

ORION (Maker: Ferranti Ltd)
Size: Medium Large. *Price:* £120,000 to £300,000.
Applications: Large and medium scale commercial data processing systems of various kinds; all forms of technical and commercial computing.
Delivery: First production model about September 1961.

DESIGN of Orion is based on 'neuron' logical elements which proved successful in Sirius—a method which permits building up of complex systems with a minimum of components. The purchaser can begin with a small nucleus and gradually enlarge

the system without invalidating existing programs. Orion is fully transistorised.

Machine is designed for time-sharing—that is, several programs may be stored simultaneously, the computer automatically allotting calculating and input/output time among these in the most efficient and economical way. Built-in facilities ensure that programs do not interfere with one another in any way.

Orion can use any currently available input and output equipment. A typical installation includes the following peripheral equipment: two paper tape readers and three punches varying in speed from medium to very fast; a high-speed card punch and two readers; four magnetic tape mechanisms and a very high-speed line printer. An additional paper tape reader and a character printer are mounted on the control console.

Main storage is on magnetic cores, capacity of which can be varied to suit the user. It is backed by one or more magnetic drums, as required. Magnetic tape units for additional storage operate at a speed comparable with that of computing (thereby contributing significantly to overall speed). These are very much faster than tape storage units used on previous Ferranti computers. Use is made of microprogramming.

Autocode methods can be used for programming.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: Contents of 1 register plus or minus those of another transferred to a third in 64 microseconds.
Multiplication: 64 to 200 microseconds.
Division: 100 to 900 microseconds.
Internal Storage:
Magnetic core: 4,096 to 16,384 words of 48 binary digits each. Floating point optional extra. When items are short, more than one can be stored in each word.
Input/Output/External Storage:
Input: Ferranti paper tape reader for 5 or 7 track tape: 1,000 or 300 characters per second, according to model.
Latest types of punched card reader.
Keyboard machines.
Output: Tape punches with 33, 60 or 300 characters per second according to model.
Latest types of card punches.
Latest type punched card type line-printers.
Xeronic printer. 3,000 lines per minute.
Flexowriter or other character printer. 10 characters per minute.
Storage: Several magnetic drums. Capacity 16,384 x 48-bit words each.
Several Ampex FR 300 magnetic tape units operating at speed corresponding to about 45,000 x 80-column cards per minute.
Maximum number of input/output units: Virtually unlimited.

ATLAS—(Maker—Ferranti Ltd)
Size: Large. *Price:* £1,000,000 to £3,000,000.
Applications: Any large-scale technical, scientific or commercial data-processing project.
Delivery: First production model, early 1962.

LARGEST computer in the world, with the single exception of Stretch (IBM), Atlas is a truly general purpose machine. It has been developed from a prototype known as Muse, designed by Manchester University and Ferranti in collaboration.

Designed for time-sharing of programs, Atlas is a very high-speed parallel computer. Fast working is achieved by transistor circuits; core store with access time of only 2 microseconds, and facilities for access to several sections simultaneously; a new method of fast carry propagation in the parallel adder associated with the central accumulator; and by careful organisation of the whole computer.

Over 300 program instructions are available. About one-third of these are basic instructions which are obeyed direct. Remainder are concerned with a system known as Extracode. This, in brief, is a method of 'pre-packaging' a sequence of instructions in a special fast-access store—comparable with the 'micro program' method used in Leo III.

Address system allows for more than 2,0000,00 words in the main store. This comprises a magnetic core, magnetic drums and fixed store, the only size limits being that of cost. Core capacity can be any multiple of 4,096 words (minimum 16,384). Any number of magnetic drums, each with 24,576-word capacity can be used. Minimum capacity of the fixed store is 4,096 words and a further block of 1,024 words is provided as working space for routines held in the fixed store. To the programmer, the varied nature of the main store is immaterial, because of automatic transfer arrangements and a built-in organisation program which minimises transfers.

In addition to the main store there are 128 registers, used for modifying instructions, each holding 24 binary digits.

Virtually any peripheral equipment can be used with Atlas. Each will have its own control equipment and buffer store, information transfer between main store and buffers being under the control of fixed routines held in the fixed store. Amount of equipment for each peripheral unit is thus kept to a minimum without reducing overall speed of the system.

A comprehensive automatic program scheme in course of preparation includes both mathematical and commercial applications. The scheme is a development of the auto-code system used on Mercury.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 1.1 microseconds for 48 binary digits (floating point).
Multiplication & Division: 3.5 microseconds for 48 binary digits (floating point).
Internal Storage:
Magnetic core. Any multiple of 4,096 words (minimum 16,384). Access to several sections simultaneously. Access time 2 microseconds.
Any number of magnetic drums, each with 24,576-word capacity.
Fixed store. Minimum capacity, 4,096 words plus further 1,024 words of core store as working space for fixed store.
127 x 24-bit registers for modifying instructions.
Input/Output/External Storage:
Input: Any number of units, any type, including punched card and punched tape readers.
Output: Any number of units, any type, including tape punches, card punches, high-speed printers.
Storage: Up to 32 tape units with one controller for each group of 4. Ampex units, 1 inch wide, 16 tracks. 300 digits per inch on each of the 12 information tracks. Transfer speed 11 microseconds per word.
Maximum number of input/output units: No limit.

650—(Maker—IBM United Kingdom Ltd)
Size: Medium *Price:* £70,000 to £200,000
Applications: Chiefly commercial data processing systems—*eg.* inventory control, production control, &c.
Delivery: As required.

DESIGNED on the building-block principle, like many other IBM systems, 650 allows the user to start with a modest basic unit. To this, vastly increased storage capacity in three different media—magnetic core, magnetic tape, random-access magnetic discs—can be added unit by unit.

For input and output, two different read-punch systems for cards can be used alternatively or together. The 533 unit has two feeds, one reading information into the computer at a speed of 200 cards per minute, the other punching out results at half this speed. The 537 system, with one feed, reads and punches results into the same set of cards, carrying out both functions at a speed of 155 cards per minute. Using these two systems together permits, for example, processing of master and detail file combinations without preliminary matching or collating.

Direct output printing is achieved by attaching a modified version of the 421 accounting machine (IBM's name for a tabulator). When attached to the 650, this machine, which has its own control panel governing print-out format, will list information, send data into the 650 to be processed and accept results from it for printing, storing or accumulating. When not employed in this capacity, the 421 can be disconnected to operate independently. A summary punch can be attached to it.

Any combination of card read-punches and output printers up to a total of three can be connected to 650.

When random access disc storage units (which have a total capacity ranging from 6,000,000 to 24,000,000 digits, according to the number of units used) are added to the 650 system, direct interrogation methods can be used. Enquiries are made direct to the storage unit from up to 10 separate electric typewriters, answers being automatically printed out on the same machines.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 0.77 milliseconds. Average access time 2.4 milliseconds.
Multiplication: 10 x 10 digits, 12 milliseconds.
Division: 20 ÷ 10 digits, 16 milliseconds.
Internal Storage:
Magnetic drum. 20,000 decimal digits.
Input Output External Storage:
Input: 533 card read-punch. Read speed 200 cards per minute. 537 card read-punch. Read speed 155 cards per minute. Up to 10 typewriter enquiry stations (usable with disc storage)
Output: 533 card read-punch. Punching speed 100 cards per minute. 537 card read-punch. Punch speed 155 cards per minute. Typewriter enquiry stations (see input)
421 line printer, with or without summary punch. 150 x 100-character lines per minute
Storage: Immediate access magnetic core. 600 digits data and instructions.
Up to 6 magnetic tape units. Each tape 2,400 feet, capacity 200 characters per inch. Read-write speed 75 inches per second.
Up to 4 magnetic disc stores. Total capacity 6,000,000 to 24,000,000 digits.
Maximum number of input/output units: Three. Plus up to 10 enquiry stations when magnetic disc store is used

305 RAMAC—(Maker—IBM United Kingdom Ltd)
Size: Medium *Price:* £65,000 to £200,000
Applications: Stock records, invoicing, plant statistics, general commercial accounting, etc.
Delivery: As required.

SPECIAL feature of the 305 Ramac system is that it provides quick and random access to information stored on one or two disc storage units each with a capacity of 5,000,000 digits. In practical terms this means, for example, that one disc unit can hold details (containing up to 100 characters) relevant to 30,000 customers and 10,000 items of inventory, leaving space for 10,000 further records for, say, details of suppliers.

In effect then, this storage system is a giant electronic card index, whose contents are recorded, updated and searched by the computer. Enquiries are made by an operator at any time via a console keyboard, the reply being automatically recorded on an electric typewriter mounted on the same unit.

The computing unit of the 305 Ramac uses a stored program, and has magnetic core and magnetic drum storage. Alphabetical and numerical information is handled and can be of variable field length.

For input, punched cards are read at a speed of 125 per minute. To accelerate data input, several transactions can be recorded on each card. Card reading can occur simultaneously with other programmed operations.

For output there is a card punch (up to 100 cards per minute) and a printer with a speed of up to 80 lines per minute. These two units can operate simultaneously.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 30 milliseconds
Multiplication: 20 milliseconds plus 10 milliseconds for each multiplier digit
Division: 20 milliseconds plus 20 milliseconds for each quotient digit
Internal Storage:
Magnetic drum for storage of up to 200 program instructions. When more than 200 instructions, these are stored on discs.
Magnetic core, capacity 100 characters. Used for data transfer.
Input/Output/External Storage:
Input: Punched card reader. Up to 125 cards per minute
Paper tape reader
Manual enquiry system under program control
Output: Card punch. 100 cards per minute.
Up to 4 remote printing stations, which can include enquiry facilities and be situated at distances up to 2,500 feet from computer
Printer. From 30 x 80-character lines per minute to 80 x 20-character lines per minute
Line printer (alternative to above)
Automatic typewriter for answering queries or as supplementary printer. 10 characters per second, 106 per line.
Storage: One or two disc storage units. Capacity 5,000,000 alphanumerical characters each. Dual control system permits two Ramac systems to work independently but in conjunction with same disc file.
Maximum number of input/output units: Two input, five output, plus enquiry stations

704—(Makers—IBM United Kingdom Ltd)
Size: Large *Price:* £300,000 to £1,000,000
Applications: Chiefly scientific & technical
Delivery: As required.

COMPUTERS by IBM can most conveniently be classified into two broad groups—those intended primarily for scientific work and machines with a greater emphasis on commercial data processing applications. The 704 falls into the first of these categories. It replaces the 701, an earlier and slower computer with smaller internal storage capacity, fewer program instructions and internal storage in electrostatic tubes.

Internal storage in the 704 is on magnetic cores, with a choice of four different capacities, ranging from 4,096 to 32,768 words. There is also a magnetic drum with a choice of two capacities. External storage is available in the form of up to 10 magnetic tape units.

Input is by a single punched card reader; output comes through on one card punch and one printer. In addition, independent peripheral units can transcribe information from punched cards direct to magnetic tape or vice-versa. Computation can proceed during all input and output operations.

The 704 is built on the unit system to facilitate the assemblage of different types of components, as required by each user. It operates on fixed or floating decimal point arithmetic.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: Fixed decimal point, 24 microseconds.
Floating decimal point, 84 microseconds.
Multiplication: Fixed decimal point 240 microseconds.
Floating decimal point 204 microseconds.
Division: Fixed decimal point 240 microseconds.
Floating decimal point 216 microseconds.
Square Root: 2.1 microseconds (sub-routine with linkage).
Internal Storage:
Magnetic core. Capacity 4,096, 8,192, 16,384 or 32,768 x 36-binary-digit words. Access time, 12 microseconds.
Magnetic drum. Capacity 8,192 or 16,384 x 36-binary-digit words. Transmission speed, 10,000 words per second.
Input Output External Storage:
Input: Card reader. Speed 150 or 250 cards per minute, according to model.
Magnetic tape unit (details transcribed from cards by independent peripheral units at 850 words per second)
Output: Card punch. 100 cards per minute
Line printer. 150 x 72-character *or* 75 x 120-character lines per minute.
Magnetic tape unit. (Details printed or punched by independent peripheral units.)
Cathode ray tube for visual display.
Storage: Magnetic tape units; 900,000 to 9,000,000 words total capacity according to number of units used. Max. number: 10; Speed 75 inches per second; transfer, 90,000 binary digits per second.

Maximum number of input output units. Up to 10 tape units. One each card reader, card punch, output printer.

705-III—(Maker—IBM United Kingdom Ltd)
Size: Large *Price:* £300,000 to £1,000,000
Applications: Commercial data processing of all kinds.
Delivery: As required.

LATEST in the 705 series is the 705-III. This is beginning to supersede the earlier 705-II which, in its turn, replaced the 705-I, now no longer in production. The 705's can be considered as the commercial parallels of the same maker's 701, 704 and 709 scientific machines.

There are several important differences between the 705-III and its immediate predecessor. Its arithmetic is faster; it has an immediate access core store with a capacity of up to 80,000 decimal digits (there is also an accumulator and auxiliary store; and external drum storage as an optional feature). An entirely new feature, the data synchroniser, controls up to 10 magnetic tape units, allowing them to operate simultaneously with calculations on the central processing unit. Up to six synchronisers may be used, and all can operate independently and simultaneously. This allows such tasks as reading input data from one magnetic tape, recording results on another and performing calculations all to be done at the same time.

Input to the 705-III is by punched cards or (as mentioned above) by magnetic tape. For output there is a card punch; a document originating machine or accounting machine (tabulator) controlled by a tape data selector; a choice of three line printers each with a different speed; and an output typewriter which reproduces 600 alpha-numerical characters per minute.

An Autocode program procedure can be used.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 11.4 per millisecond
Multiplication: 1.7 per millisecond (5 x 5 digits)
Division: 700 per second (6 ÷ 4 digits)
Internal Storage:
Magnetic core with 40,000 or 80,000 character capacity.
Transfer speed 111,000 characters per second.
Accumulator & auxiliary store: 256 characters each.
Input Output External Storage:
Input: Card reader. Maximum speed 250 cards per minute.
Magnetic tape (with data synchroniser)
Output: Card punch. Maximum speed 100 cards per minute
Tape data selector for format control of document-originating machine or accounting machine (tabulator).
Output printers with 150, 500 or 1,000 lines per minute maximum speeds, according to model
Typewriter. 600 alpha-numeric characters per minute.
Storage: Magnetic drum. 60,000 characters in 300 sections x 200 characters each. Transfer time, 25,000 characters per second.
Up to 60 magnetic tape units. Each reel 2,400 feet long. 200 or 534 characters per inch, transfer rate 15,000 or 60,000 characters per second, read-write speed 75 or 112.5 inches per second, according to type chosen.
Maximum number of input output units: Up to 6 data synchronisers, each controlling 10 magnetic tape units. Other input/output equipments as required.

7070—(Maker—IBM United Kingdom Ltd)
Size: Large to medium *Price:* £200,000 upwards
Applications: General commercial data processing; scientific and technical work.
Delivery: As required

THE 7070 was first in a line of transistorised IBM computers which now includes 7080 and 7090. Much smaller than valve machines, it also needs much less power and much less air-conditioning equipment.

Designed for time-sharing, 7070 has very high input and output speeds. A feature known as 'priority processing' makes best possible use of input and output channels. When one program is delayed by an input-output interlock, the computer automatically transfers to another program. As soon as the lock is released, it goes back to the first. This system allows two programs—one with considerable calculation and moderate input-output, the other with heavy input-output and little calculation—to be dovetailed together so that total running time is little more than for a single program.

One example of this process 'Spool' (simultaneous peripheral operations on line) allows performance of routine tape-to-card printer and card-to-tape operations without special off-line equipment.

Building block design is used in 7070. To the basic magnetic core storage, additional capacity in the form of up to 12 magnetic tape units, and Ramac magnetic disc units with a total capacity of 12,000,000 digits and each with associated enquiry stations can be added.

A number of standard programs will be available. In addition, programs in the library, originally written and tested for use on other IBM computers, are being translated for use on the 7070. The machine can use autocode procedures.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 60 microseconds for 5 digits; 72 microseconds for 10 digits
Multiplication: 0.7 to 1.6 milliseconds for 10 digits
Division: 0.8 to 5 milliseconds for 10 digits
Internal Storage:
Magnetic core. 5,000 or 9,990 x 10-decimal-digit words. Access time, 6 microseconds.
Input Output External Storage:
Input: Punched card reader. 500 cards per minute
Up to 10 enquiry typewriters (for use with disc storage) at distances up to 2,500 feet from computer
Using 1401 system as auxiliary: Card reader 800 cards per minute
Output: Card punch. 250 cards per minute
Line printer. 150 x 120-character lines per minute (One card punch or line printer can be attached to each of up to three output synchronisers (buffers)
Using 1401 system as auxiliary: Output printer, 600 lines per minute
Storage: Up to 40 magnetic tape units. Two channels for transfer between tape Ramac primary store. Two models of tape. (1) 200 caracters per inch. (2) 556 characters per inch. Passing speed 75 and 112.5 inches per second. Transfer rate 15,000 and 62,500 characters per second. Start stop time 10 and 7.5 milliseconds.
Up to 4 random access magnetic disc units. Capacity 6,000,000 or 12,000,000 digits each.
Maximum number of input output units: Up to 3 of each. Plus up to 10 enquiry typewriters.

7080—(Maker—IBM United Kingdom Ltd)
Size: Large *Price:* £800,000 upwards
Applications: All commercial data processing; scientific & technical work.
Delivery: As required.

A MEMBER of the 705 family of computers, the 7080 is a transistorised system—latest in the series. The machine can use any program designed for the 705, provided similar input-output units are used; and peripheral equipment employed with existing 705-I, II or III computers may be attached through a signal control unit. Conversion from a 705 to a 7080 system may, therefore, be made with minimum difficulty and expense.

Major features of the 7080, in addition to those already provided by the 705 system are: internal processing speeds six times as fast as those in the 705-III; expandable input-output capacity with up to five simultaneous operations overlapping with processing; input-output priority processing which maximises communication channel utilisation and the total efficiency of the system; magnetic core storage expandable to a total capacity of 160,000 character positions and an extra set of 15 channel auxiliary storage units for input-output routines. The 7080 has 18 new and improved operations, including simultaneous transmission which overlaps data transmission with processing and magnetic tape reading and writing.

A comprehensive program library will be available as an integral part of the 7080 system. This will include autocode routines.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 78,000 per second
Multiplication: 7,100 per second
Division: Not given
Internal Storage:
Magnetic core—three patterns. Model 1: 160,000 characters; Model 2: 80,000 characters. Model 3: 40,000 characters.
Cycle rate 2.18 microseconds.
Auxiliary storage of 1012 characters, including tape buffer storage. Cycle rate 1.09 microseconds.
Input Output External Storage:
Input: Card reader, 250 cards per minute
Output: Card punch, 100 cards per minute
Printers. Speeds 150, 500 or 1,000 x 120-character lines per minute, according to model
Tape control unit controlling up to 10 Model 727 tape units
Tape data selector with accounting machine or document reproducing machine.
Tape record co-ordinator controlling up to 8 Model 727 tape units.
Storage: Up to 50 Model 729 tape units in either of two types: (1) 2,400 feet long. Read-write speed 75 inches per second. Character density 200 or 556 characters per inch. (2) 2,400 feet long. Read-write speed 112.5 inches per second. Character density 200 or 556 characters per inch.
Up to 30 magnetic drums. Capacity of each 60,000 characters in 300 sections x 200 characters.
Total number of input output units: Up to 10 of the units listed and up to 50 tape units.

704—(Makers—IBM United Kingdom Ltd)
Size: Large *Price:* £300,000 to £1,000,000
Applications: Chiefly scientific & technical
Delivery: As required.

COMPUTERS by IBM can most conveniently be classified into two broad groups—those intended primarily for scientific work and machines with a greater emphasis on commercial data processing applications. The 704 falls into the first of these categories. It replaces the 701, an earlier and slower computer with smaller internal storage capacity, fewer program instructions and internal storage in electrostatic tubes.

Internal storage in the 704 is on magnetic cores, with a choice of four different capacities, ranging from 4,096 to 32,768 words. There is also a magnetic drum with a choice of two capacities. External storage is available in the form of up to 10 magnetic tape units.

Input is by a single punched card reader; output comes through on one card punch and one printer. In addition, independent peripheral units can transcribe information from punched cards direct to magnetic tape or vice-versa. Computation can proceed during all input and output operations.

The 704 is built on the unit system to facilitate the assemblage of different types of components, as required by each user. It operates on fixed or floating decimal point arithmetic.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: Fixed decimal point, 24 microseconds.
Floating decimal point, 84 microseconds.
Multiplication: Fixed decimal point 240 microseconds.
Floating decimal point 204 microseconds.
Division: Fixed decimal point 240 microseconds.
Floating decimal point 216 microseconds.
Square Root: 2.1 microseconds (sub-routine with linkage).
Internal Storage:
Magnetic core. Capacity 4,096, 8,192, 16,384 or 32,768 x 36-binary-digit words. Access time, 12 microseconds.
Magnetic drum. Capacity 8,192 or 16,384 x 36-binary-digit words. Transmission speed, 10,000 words per second.
Input Output External Storage:
Input: Card reader. Speed 150 or 250 cards per minute, according to model.
Magnetic tape unit (details transcribed from cards by independent peripheral units at 850 words per second)
Output: Card punch. 100 cards per minute
Line printer. 150 x 72-character *or* 75 x 120-character lines per minute.
Magnetic tape unit. (Details printed or punched by independent peripheral units.)
Cathode ray tube for visual display.
Storage: Magnetic tape units; 900,000 to 9,000,000 words total capacity according to number of units used. Max. number: 10; Speed 75 inches per second; transfer, 90,000 binary digits per second.

Maximum number of input output units. Up to 10 tape units. One each card reader, card punch, output printer.

705-III—(Maker—IBM United Kingdom Ltd)
Size: Large *Price:* £300,000 to £1,000,000
Applications: Commercial data processing of all kinds.
Delivery: As required.

LATEST in the 705 series is the 705-III. This is beginning to supersede the earlier 705-II which, in its turn, replaced the 705-I, now no longer in production. The 705's can be considered as the commercial parallels of the same maker's 701, 704 and 709 scientific machines.

There are several important differences between the 705-III and its immediate predecessor. Its arithmetic is faster; it has an immediate access core store with a capacity of up to 80,000 decimal digits (there is also an accumulator and auxiliary store; and external drum storage as an optional feature). An entirely new feature, the data synchroniser, controls up to 10 magnetic tape units, allowing them to operate simultaneously with calculations on the central processing unit. Up to six synchronisers may be used, and all can operate independently and simultaneously. This allows such tasks as reading input data from one magnetic tape, recording results on another and performing calculations all to be done at the same time.

Input to the 705-III is by punched cards or (as mentioned above) by magnetic tape. For output there is a card punch; a document originating machine or accounting machine (tabulator) controlled by a tape data selector, a choice of three line printers each with a different speed; and an output typewriter which reproduces 600 alpha-numerical characters per minute.

An Autocode program procedure can be used.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 11.4 per millisecond
Multiplication: 1.7 per millisecond (5 x 5 digits)
Division: 700 per second (6 — 4 digits)
Internal Storage:
Magnetic core with 40,000 or 80,000 character capacity.
Transfer speed 111,000 characters per second.
Accumulator & auxiliary store: 256 characters each.
Input Output External Storage:
Input: Card reader. Maximum speed 250 cards per minute.
Magnetic tape (with data synchroniser)
Output: Card punch. Maximum speed 100 cards per minute
Tape data selector for format control of document-originating machine or accounting machine (tabulator).
Output printers with 150, 500 or 1,000 lines per minute maximum speeds, according to model
Typewriter. 600 alpha-numeric characters per minute.
Storage: Magnetic drum. 60,000 characters in 300 sections x 200 characters each. Transfer time, 25,000 characters per second.
Up to 60 magnetic tape units. Each reel 2,400 feet long. 200 or 534 characters per inch, transfer rate 15,000 or 60,000 characters per second, read-write speed 75 or 112.5 inches per second, according to type chosen.
Maximum number of input output units: Up to 6 data synchronisers, each controlling 10 magnetic tape units. Other input/output equipments as required.

7070—(Maker—IBM United Kingdom Ltd)
Size: Large to medium *Price:* £200,000 upwards
Applications: General commercial data processing; scientific and technical work.
Delivery: As required

THE 7070 was first in a line of transistorised IBM computers which now includes 7080 and 7090. Much smaller than valve machines, it also needs much less power and much less air-conditioning equipment.

Designed for time-sharing, 7070 has very high input and output speeds. A feature known as 'priority processing' makes best possible use of input and output channels. When one program is delayed by an input-output interlock, the computer automatically transfers to another program. As soon as the lock is released, it goes back to the first. This system allows two programs—one with considerable calculation and moderate input-output, the other with heavy input-output and little calculation—to be dovetailed together so that total running time is little more than for a single program.

One example of this process 'Spool' (simultaneous peripheral operations on line) allows performance of routine tape-to-card printer and card-to-tape operations without special off-line equipment.

Building block design is used in 7070. To the basic magnetic core storage, additional capacity in the form of up to 12 magnetic tape units, and Ramac magnetic disc units with a total capacity of 12,000,000 digits and each with associated enquiry stations can be added.

A number of standard programs will be available. In addition, programs in the library, originally written and tested for use on other IBM computers, are being translated for use on the 7070. The machine can use autocode procedures.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 60 microseconds for 5 digits; 72 microseconds for 10 digits
Multiplication: 0.7 to 1.6 milliseconds for 10 digits
Division: 0.8 to 5 milliseconds for 10 digits
Internal Storage:
Magnetic core. 5,000 or 9,990 x 10-decimal-digit words. Access time, 6 microseconds.
Input Output External Storage:
Input: Punched card reader. 500 cards per minute
Up to 10 enquiry typewriters (for use with disc storage) at distances up to 2,500 feet from computer
Using 1401 system as auxiliary: Card reader 800 cards per minute
Output: Card punch. 250 cards per minute
Line printer. 150 x 120-character lines per minute (One card punch or line printer can be attached to each of up to three output synchronisers (buffers)
Using 1401 system as auxiliary: Output printer, 600 lines per minute
Storage: Up to 40 magnetic tape units. Two channels for transfer between tape/Ramac/primary store. Two models of tape. (1) 200 caracters per inch. (2) 556 characters per inch. Passing speed 75 and 112.5 inches per second. Transfer rate 15,000 and 62,500 characters per second. Start/stop time 10 and 7.5 milliseconds.
Up to 4 random access magnetic disc units. Capacity 6,000,000 or 12,000,000 digits each.
Maximum number of input output units: Up to 3 of each. Plus up to 10 enquiry typewriters.

7080—(Maker—IBM United Kingdom Ltd)
Size: Large *Price:* £800,000 upwards
Applications: All commercial data processing; scientific & technical work.
Delivery: As required.

A MEMBER of the 705 family of computers, the 7080 is a transistorised system—latest in the series. The machine can use any program designed for the 705, provided similar input-output units are used; and peripheral equipment employed with existing 705-I, II or III computers may be attached through a signal control unit. Conversion from a 705 to a 7080 system may, therefore, be made with minimum difficulty and expense.

Major features of the 7080, in addition to those already provided by the 705 system are: internal processing speeds six times as fast as those in the 705-III; expandable input-output capacity with up to five simultaneous operations overlapping with processing; input-output priority processing which maximises communication channel utilisation and the total efficiency of the system; magnetic core storage expandable to a total capacity of 160,000 character positions and an extra set of 15 channel auxiliary storage units for input-output routines. The 7080 has 18 new and improved operations, including simultaneous transmission which overlaps data transmission with processing and magnetic tape reading and writing.

A comprehensive program library will be available as an integral part of the 7080 system. This will include autocode routines.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 78,000 per second
Multiplication: 7,100 per second
Division: Not given
Internal Storage:
Magnetic core—three patterns. Model 1: 160,000 characters; Model 2: 80,000 characters. Model 3: 40,000 characters.
Cycle rate 2.18 microseconds.
Auxiliary storage of 1012 characters, including tape buffer storage. Cycle rate 1.09 microseconds.
Input Output External Storage:
Input: Card reader, 250 cards per minute
Output: Card punch, 100 cards per minute
Printers. Speeds 150, 500 or 1,000 x 120-character lines per minute, according to model
Tape control unit controlling up to 10 Model 727 tape units
Tape data selector with accounting machine or document reproducing machine.
Tape record co-ordinator controlling up to 8 Model 727 tape units.
Storage: Up to 50 Model 729 tape units in either of two types: (1) 2,400 feet long. Read-write speed 75 inches per second. Character density 200 or 556 characters per inch. (2) 2,400 feet long. Read-write speed 112.5 inches per second. Character density 200 or 556 characters per inch.
Up to 30 magnetic drums. Capacity of each 60,000 characters in 300 sections x 200 characters.
Total number of input/output units: Up to 10 of the units listed and up to 50 tape units.

7090—(Maker—IBM United Kingdom Ltd)
Size: Large *Price:* £880,000 upwards
Applications: Commercial data processing of all kinds; scientific & technical problems
Delivery: As required

LARGEST of the general purpose computers now being produced in quantity by IBM, 7090 is a transistorised system. Its internal speed is more than six times faster than the 709; it has a large capacity magnetic core store, but no magnetic drums, all other data being stored on magnetic tape units.

Like the 7080, the 7090 has a system (in this case known as Multiplexor) which permits computation to proceed simultaneously with automatically-controlled multiple input-output channels. This, along with other design features, ensures that machine time is used with maximum efficiency.

Eight input-output channels are available; to each of these up to 10 magnetic tape units, a punched card reader and a printer may be connected. Therefore, for practical purposes, there is no limit to the number of peripheral equipments which may be used.

Input-output units and the magnetic tape units are compatible with other IBM data processing systems. There is also direct program compatibility with the 709 for all programs not using magnetic drum storage or cathode ray tube displays; and a special compatibility feature for simulating 709 programs wth drum storage and executing unedited 704 programs using not more than half the core storage of the 7090.

There is a choice of two types of magnetic tape unit. Used together, these give a choice of four different transmission speeds.

More than 200 program instructions are available for the 7090 system. It employs automatic fixed point, floating point and logical operations.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: Fixed decimal point, 4.36 microseconds.
Floating point, 13.08 to 32.7 microseconds.
Multiplication: Fixed decimal point, 4.36 to 30.52 microseconds.
Floating point, 4.36 to 28.34 microseconds.
Division: Fixed decimal point, 6.54 to 30.52 microseconds.
Floating point, 6.54 to 28.34 microseconds.
Logical operations: 2.18 or 4.36 microseconds.
Internal Storage:
Magnetic core. Capacity 32,768 x 36-binary-digit words.
Input Output External Storage:
Input: Up to 8 card readers. 250 cards per minute
Output: Up to 8 card punches. 100 cards per minute
Up to 8 Output printers. 150 x 120-character lines per minute.
Storage: Up to 80 tape units, mixed if required, of the two following types: (1) 2,400 feet. Character density, 1,200 or 2,330 binary digits per inch. Read-write speed 75 inches per second, transfer rate 90,000 or 247,500 binary digits per second. Start-stop time 10.8 milliseconds. (2) 2,400 feet. Character density 1200 or 3330 binary digits per inch. Read-write speed 112.5 inches per second, transfer rate 135,000 or 375,000 binary digits per second. Start-stop time 7.3 milliseconds.
Maximum number of input output units: Up to 8 data channels each using a unit which can accommodate up to 10 magnetic tape units of either type, one card reader, one card punch and one printer; or up to 10 magnetic tape units only.

STRETCH—(Makers—IBM United Kingdom Ltd)
Size: Very large *Price:* Not yet announced
Applications: Commercial and other data processing systems of all kinds with requirements greater than can be met by existing systems.
Delivery: To special order only

FEW precise details are yet available on Stretch—a computing system so called because its capacity stretches the imagination, the makers say. Transistorised, Stretch is at least 75 to 100 times more powerful than the large-scale IBM 704 and 709 machines, yet occupies no more floor space.

Stretch can perform well over 1,000,000 logical operations per second; can complete more than 1,000,000,000 arithmetical operations per day. A typical system with six magnetic core storage units would have an internal capacity of more than 1,500,000 decimal digits. Data can be extracted from store in half a microsecond.

A device known as the 'exchange' gives maximum efficiency in handling input-output devices. Capable of handling 2,000,000 computer words per second, the exchange routes information between the internal system and up to 32 data channels (*cf.* eight for the 7090 system), each of which can employ many input-output devices.

Other features include: priority interrupt—the computer can cease current work and turn to an urgent job; a new and greatly simplified programming procedure; more self checking and self correcting facilities than are available in any other computer.

1301—(Makers—I.C.T. Ltd)
Size: Medium *Price:* £65,000 to £250,000
Applications: Management accounting, production and sales control, payroll, invoicing, hire purchase accounting; linear and non-linear programming, games technique; work study, &c.
Delivery: As required.

CONSIDERABLY more powerful than any other computer by these makers, their latest to appear on the market, 1301 has a fully transistorised computing unit. Designed on the building block system, it provides for expandable immediate access and magnetic drum stores, and for the use of up to eight magnetic tape storage units either of standard or high-speed type.

Input is by 80-column punched cards read at a speed of 600 per minute. Output is by card punch (100 cards per minute) or printer. Printing speed is up to 600 lines per minute and skip speed (movement of blank portions of forms) is 400 feet per minute.

Card punching and reading and printing can proceed simultaneously; off-line printing can be done from magnetic tape.

Programs are punched into cards and controlled by a unit comprising three 6-digit registers. The machine is designed primarily to work in fixed-point, but a full range of routines is provided for floating-point operation. An autocode program procedure can be used and there is a program library.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 21 microseconds.
Multiplication: 170 microseconds per multiplier digit.
Division: By program.
Internal Storage:
Immediate access core: 400 to 2,000 x 12-decimal-digit words in 400-word multiples.
Up to 8 magnetic drums, each with capacity of 12,000 words.
Input/Output/External Storage:
Input: Punched card reader; 600 x 80-column cards per minute. Hopper capacity 2,000; stacker capacity 2,000; auxiliary stacker, 500.
Magnetic tape (see storage below).
Output: Card punch: 100 x 80-column cards per minute. Hopper capacity 800; stacker capacity 650, with offset facility.
Storage: From 1 to 8 magnetic tape decks, all belonging to either one of the following types. (1) High speed. 1-inch' tape, 16 tracks, 600 decimal digits per inch. Speed 150 inches per second. Read-write speed 90,000 decimal digits per second. Stop-start speed 8.6 microseconds. Capacity 25,000,000 digits per reel. (2) Standard. ½-inch tape, 10 tracks, 300 decimal digits per inch. Speed 75 inches per second, read-write speed 22,500 decimal digits per second. Stop-start time 11 microseconds.
Maximum number of input/output units: One card input, one card and one printer output. Up to 8 magnetic tape units.

LEO IIC—(Maker—Leo Computers Ltd)
Size: Medium *Price:* £125,000 upwards
Applications: Commercial data processing—*eg.* payroll, production and stores control, sales accounting and forecasting, insurance.
Delivery: As required.

THE now defunct Leo I was succeeded by Leo II, of which IIC is the latest version. The latter, though still on sale and likely to be in use for some time, will eventually be replaced by Leo III (described separately).

Designed specifically to cover thoroughly the entire range of commercial applications (though it can also be used for technical and scientific work), Leo IIC gives provision for up to four input channels, with which any type of reading unit may be employed; and up to three output channels for a wide variety of equipment. Each channel has its own buffer store—or two, for some output units where loading may be uneven.

Main internal store is a magnetic core, basic size of which—2,048 positions—may be expanded to four times this capacity. Where more internal storage is required, extra core stores in units of 8,192 positions, and up to four magnetic drums may be added.

External storage is provided by up to 16 magnetic tape units, each group of up to eight having its own controller. Off-line card-punching or print-out can be carried out direct from magnetic tape store.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 0.4 milliseconds.
Multiplication: Variable.
Division: 300 per second.
Internal Storage:
Magnetic core: 1,024 to 8,192 39-binary-digit words, divisible into half-words. Access time, 10 microseconds.
Magnetic drum: 8,192 to 32,768 words. Average access time, 10 microseconds.
Input Output/External Storage:
Input: Paper tape reader: 200 characters per second.
Punched card reader: 200 cards per minute.
Magnetic tape: maximum effective speed 360 words per second.
Output: Card punch: 100 cards per minute.
Line printers: 100, 150 or 300 lines per minute, according to model.
Magnetic tape: maximum effective speed 360 words per second.
Storage: Up to 16 magnetic tape units, each group of eight with its own controller.
Maximum number of input/output units: Up to four input, three output.

LEO III—(Maker—Leo Computers Ltd)
Size: Medium to large. *Price:* £200,000 upwards.
Applications: Any type of commercial, mathematical and scientific work.
Delivery: First production model, Spring 1962.

NEWEST machine in Leo line, Leo III is all-transistorised, and is built on the unit principle so that extra peripheral equipment can be added after initial installation.

All electronic unit in standard-sized cabinets with own stabilised power arrangements fed from mains, and self-contained ventilation. No ventilation ducts needed. Floor layout completely flexible.

Perforated paper tape, punched card and magnetic tape input and output devices in any combination are linked to computing unit through 'assemblers'. Thus, the computing unit is not affected if input or output media are changed, only introduction or substitution of appropriate assemblers being required. All input and output assemblers and the arithmetic unit can work concurrently.

Leo III has a large, quick access magnetic core store with automatic checking. Operates directly in decimal, sterling, weights and measures or any other notation, without programmed conversion of numbers from one form to another either for input or output.

Has automatic program coding facilities and feature known as 'micro programming'. This, in effect, comprises a number of 'pre-fabricated' program steps of a standard format and/or routines set up to user's requirements, built into computer. Micro programming simplifies both program writing and computer maintenance.

Length of input/output blocks is variable; floating point facilities are available. The machine is built for time-sharing on two or more programs.

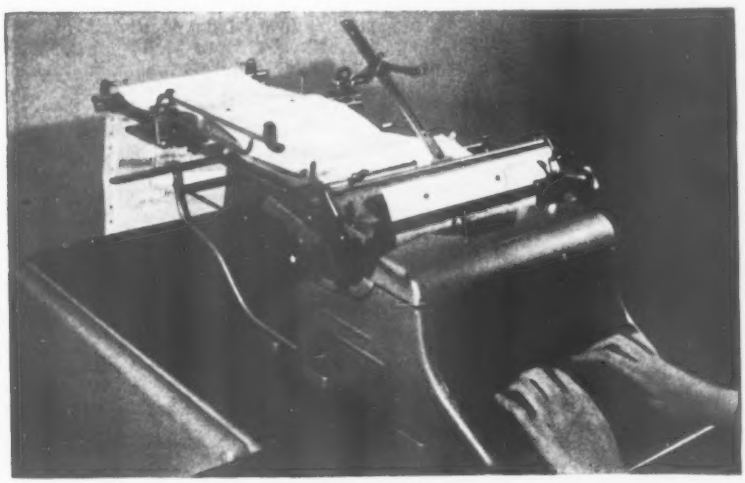
SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 44 microseconds, or 60 if modified.
Multiplication: 300-700 microseconds; 140-350 microseconds if repeated with same multiplier.
Division: 1,200 microseconds.
Internal Storage:
Magnetic core with capacity 4,096 to 32,768 words. Word length: 10 digits and sign. Cycle time: 14 microseconds.
Input Output/External Storage:
Input: Paper tape readers, speeds 300 or 1,000 charac-

Seen any good forms lately?

Do your business forms meet the needs of the Company as well as they might, or are they taken for granted?
Why not have specimens of all forms used brought in to you for a detailed check. See if they stand up to objective examination; changing patterns of business can easily outmode the original purpose of the forms. To aid you, technical advice is freely available for the asking. Catlins specialise in the design and manufacture of continuous stationery and multiple cut sets to individual needs; a talk with one of their experts may well result in a faster flow of work.

AUTOMATIC DATA PROCESSING EQUIPMENT
needs continuous stationery processed to very exacting limits; it needs Cat-Tab stationery, tailor-made to suit each machine. Here Cat-Tab Continuous Stationery is being used on the ICT Tabulator and the Bowe SV 2002 Form Handling Machine.



CONTINUOUS STATIONERY
used on billing machines will substantially increase output. Cat-Tab stationery designed for this attachment reduces manual operations to a minimum and ensures a fast output of completed forms.

May we arrange for a trial demonstration on your own machines?

A CATLIN SERVICE TO OFFICE EFFICIENCY

CAT-TAB REGD.

Purpose designed and purpose made

CONTINUOUS STATIONERY

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TBW C17

ters per second.
Punched card readers, 400 or 600 cards per minute.
Magnetic tape: 45,000 or 90,000 characters per second peak speeds.

Output: Paper tape punch, 33 characters per second.
Typewriter, 10 characters per second.
Card punch, 100 cards per minute.
Magnetic tape decks: 45,000 or 90,000 characters per second peak speeds.

Maximum number of input/output units: Any reasonable number.

405—(Maker—National Elliott)
Size: Medium. *Price:* £80,000 to £200,000.
Applications: Commercial data processing—*eg.* management accounting, statistics, invoicing, costing, payroll, insurance.
Delivery: As required.

THOUGH a new National computer is on the way (see note below), it will not supersede the 405. More accurately, the new machine, which is entirely different in concept from its predecessor, may be considered as alternative to the 405.

There are two versions of the 405, the second known as 405M. Basically, the machines are alike in every detail, with one exception. Whereas the 405 has three storage levels (nickel delay lines, magnetic discs, magnetic film), the 405M has four, the additional unit being a fast-access magnetic core. Thus, the *internal* storage capacity of 405M is almost 1,000 words greater than that of 405. Magnetic film storage (which this maker uses instead of magnetic tape) is the same for both machines.

There are two input methods—punched paper tape, punched cards; a total of three units may be used. Output may be to paper tape (which may be fed, off-line, to character printers); to magnetic film, from which it may be fed to a line printer; or to a different type of magnetic film from which it is converted to paper tape. Output may also be channelled direct to a character printer. A total of four on-line output units may be used and up to four magnetic film units of four mechanism each. Capacity of each reel of film is about 2,500,000 decimal digits.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 153 microseconds.
Multiplication & Division: 3,147 microseconds.
Internal Storage (405):
Fast access store. Up to 512 x 32-binary-digit words; average access time 800 microseconds. Plus 4 words access time 102 microseconds.
Magnetic disc: 16,384 x 32-binary-digit words.
Internal Storage (405M):
Immediate access magnetic core; 1,024 x 32-binary-digit words. Fast access nickel delay lines; 384 x 32-binary-digit words. Magnetic disc; 16,384 x 32-binary-digit words.
Input/Output/External Storage:
Input: Paper tape reader; 200, 400 or 1,000 characters per second, according to model.
Punched card reader; up to 400 cards per minute.

Output: Paper tape punch; 25 or 300 characters per second, according to model.
Character printers at 10 characters per second from serial magnetic film written at 300 characters per second and converted off-line to paper tape at 65 characters per second.
Line printer; 600 x 120-character lines per minute, operated off-line by magnetic film written at up to 1,800 characters per second.

Storage: Magnetic film; 1,000-foot reels. Capacity 2,250,000 decimal digits or 1,250,000 alphabetical characters.

Maximum number of input/output units: 3 input, 3 output; up to 4 film units of 4 mechanisms each.

Un-named Computer—(Maker—The National Cash Register Co Ltd)

FOLLOWING brief details are all we have been able to obtain about this new machine at the time of going to press.

The new computer is designed as a result of experience gained on the 304 in the USA. It will use a completely new and comprehensive range of peripheral equipment, of which the new National high-speed line printer now available in Britain (See Automatic Data Processing, page 32, June 1960) is the forerunner.

UNIVAC 80—(Maker—Remington Rand Ltd)
Size: Medium. *Price:* £120,000 to £220,000.
Applications: All types of business and industrial data processing.
Delivery: As required.

THE version of the Univac 80 available in this country is completely transistorised. It is designed to work with input and output of 80-column punched cards (the rectangular-hole variety), additional output being available in the form of printers.

The computer comprises four small units. The central processor handles arithmetic and logic, houses the storage drum, exerts control over the entire system. For input there is a card reader (450 cards per minute) and a read-punch unit (also used for output) which performs either function at 150 cards per minute. Speed of the output printer is 600 lines per minute. Another printer, described as a 'document punching printer', prints on to the cards themselves in addition to punching in data. It handles two sets of cards simultaneously, printing on each at a speed of 900 lines per minute, giving total output of 1,800 lines per minute.

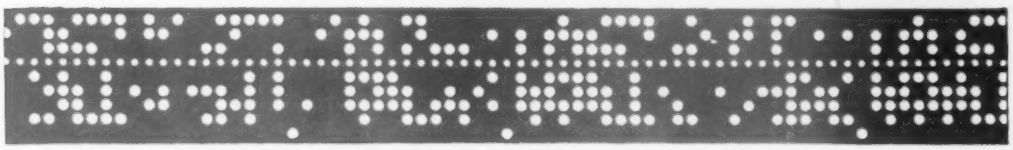
Basic storage device is a magnetic drum, divided into two areas, each with a different access time. For the 'standard' area, this is 1.7 milliseconds; in the 'high speed' area, it is 0.425 milliseconds.

Magnetic tape storage can be added. Operation of up to 10 tape units is controlled by a program-controlled synchroniser which regulates the flow of data to and from the central processor.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 85 microseconds.
Multiplication: Average 200 microseconds.
Division: Average 300 microseconds.
Internal Storage:
Magnetic drum; 4,000 x 10-digit words and arithmetical sign; access time 1.7 microseconds. 1,000 words with access time 0.425 microseconds. Total capacity, 5,000 words.
Input/Output/External Storage:
Input: Card reader; 450 cards per minute.
Card reader-punch; 150 cards per minute for both operations.

FRIDEN FLEXOWRITER

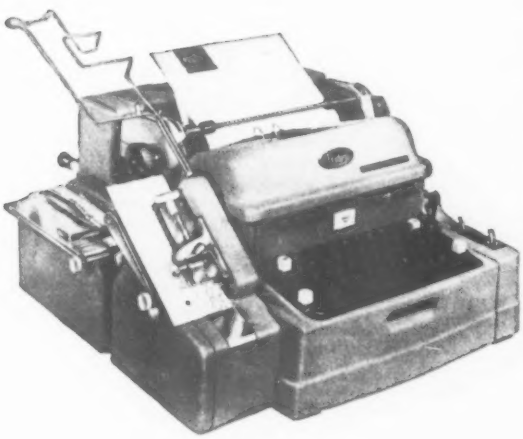


does your sales order-invoicing automatically

Speeds and streamlines work routines

Eliminates human errors

Saves time and money



The FLEXOWRITER is an automatic machine which produces a code-punched tape as a by-product of writing the original document. This punched tape is then used to create other records automatically, eliminating the continuous manual reprocessing of data that runs up office costs.

For example, the punched tape produced as an automatic by-product of a sales order automatically prepares the sales invoice, and punches cards for statistical reports. Purchase orders, goods received notes and many other records may be prepared with similar advantages.

The FLEXOWRITER may be installed one at a time, in multiple units or in connection with auxiliary equipment, thus greatly expanding its applications.

The choice of a FRIDEN FLEXOWRITER as the basic unit in an automatic office opens the broadest opportunity for continued extension of automation. Start with one FRIDEN unit, then add others as each pays for itself.

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Output; Card reader-punch (see input).
Line printer; 600 x 130-character lines per minute.
Document punching printer; 1,800 lines (900 lines on two packs of cards simultaneously) per minute.
Storage: Up to 10 magnetic tape units, controlled by synchroniser. Each unit 1,500 feet metallic or 2,400 feet Mylar tape. Speed 100 inches per second. Read-write speed 25,000 characters per second.
Maximum number of input/output units: 14 (including magnetic tape).

UNIVAC III—(Maker—Remington Rand Ltd)
Size: Large. *Price:* Probably £300,000 to £500,000.
Applications: All forms of commercial data processing.
Delivery: Not before September 1962.

NO details, other than the specifications given below, are yet available on Univac III.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Subtraction: 9 to 22.5 microseconds, according to number of words, which may vary from one to four.
Multiplication: 76.5 to 184.5 microseconds.
Division: 76.5 to 312.5 microseconds.
Internal Storage:
Magnetic core: 8,192 to 32,768 x 27-binary-digit words.
Randex mass storage drums; capacity over 200,000,000 digits.
Input/Output/External Storage:
Input: Punched card reader; 700 x 80-column cards per minute.
Magnetic tape units (see storage below).
Output: Card punch; 300 x 80-column cards per minute.
High-speed printer; 700 lines per minute.
Document punching printer; 150 cards, 1,800 lines (2 sets cards 900 lines) per minute.
Magnetic tape (see storage below).
Storage: Uniservo III tape units. Read-write speed 25,000 characters per second.
Uniservo III tape units. Read-write speed 200,000 numerals per second.
Maximum number of input/output units: About 40 (including tape) depending on configuration.

STANTEC COMPUTING SYSTEM—(Maker—Standard Telephones & Cables Ltd)
Size: Medium. *Price:* £26,500 to £150,000.
Applications: Wide variety of commercial data processing tasks; scientific and technical calculations.
Delivery: Six to nine months from receipt of order.

STANTEC comprises an extremely flexible nucleus computing device which forms the base for custom-built systems of a modular type. Peripheral equipment of varying types, speeds and capacities can be incorporated to suit individual needs.

Basic machine is small. It consists of: the transistorised computing unit; one paper tape input reader; one paper tape output punch; and a single teleprinter.

Included in the equipment which can be added are: a fast multiplier unit which can alternatively provide a facility for two extra accumulators used together as a double-length accumulator; extra storage capacity in the form of up to four 512-word ferrite blocks and up to 256 one-word ferrite registers; a choice of three different magnetic tape systems comprising a total of up to 32 units; additional paper tape input and output mechanisms; punched card equipment; an extra teleprinter; and the high-speed Xeronic printer.

Fundamentally, the Stantec transistorised computer is the same as Zebra. It can therefore accept programs written for Zebra and retains such facilities as normal and simple code programming, a large magnetic drum store, and so forth.

SPECIFICATIONS

Arithmetic Speeds:
Addition & Multiplication: 312 microseconds.
Multiplication: 11 milliseconds. (Fast multiplier, 624 microseconds).
Division: 35 milliseconds.
Internal Storage:
Magnetic drum. 8,192 x 33-binary-digit words.
Immediate access ferrite store. In blocks of 512 words up to 8,192-word total. Connected in parallel to magnetic drum.
Input/Output/External Storage:
Input: Paper tape reader for 7- or 5-hole tape. 200 characters per second. Total of 6 units can be used.
High-speed paper tape reader. (7-channel tape only). 800 characters per second. Under magnetic tape control, up to 32 can be used.
Punched card reader. 340 cards per minute. (Needs special 96-character buffer).
Output: Paper tape punch for 7- or 5-hole tape. 50 characters per second. Total of 6 units can be used, or any can be replaced by electric typewriter, speed 10-15 characters per seconds. Up to 2 teleprinters. 10 characters per second.
High speed paper tape punch. 300 characters per second. Up to 6 can be used.
Card punch. 100 cards per minute.
Battery of off-line typewriters under magnetic tape control.
Xeronic line printer. 3,000 lines per minute.
Storage: Up to 32 magnetic tape units of three kinds. (1) 100 yards, capacity about 1,250,000 alpha-numeric characters. Transfer speed 2,000 characters per second. (2) 100 yards. Capacity 10,000,000 alpha-numeric characters. Transfer speed 15,000 characters per second. (3) 2,400 feet. Capacity 8,000,000 alpha-numeric characters.
Magnetic tape control unit always needed. This connects any tape units or other inputs/outputs to buffers.
Maximum number input/output units: See separate entries above.

Next Month: Part II of the Survey will review small computing systems.

WHAT'S NEW

in systems, services and equipment

Tele-processing Equipment

AN equipment which is at present being manufactured in the USA but which should soon come to this country, is the IBM 1001 Data Transmission System. It represents a very notable breakthrough in the communications field since it allows the transmission of both fixed data—from pre-punched cards—and also variable information, which would be keyed in manually by means of a keyboard.

The system consists of one or more sending stations and a control receiving station. These stations would be linked by public or leased telephone lines.

The Sending Station

The sending station comprises a terminal with card reader and keyboard, a telephone, and a modulating sub-set available through the local telephone company. The card reader on the terminal is specified for 80, 51, and 22-column cards. The transmission is initiated by an operator dialling the appropriate calling signal. When the speaker at the terminal has signalled an audible guidance signal transmission can begin. The transmitting terminal reads the card data—a maximum of 22 consecutive columns of data per card—at a rate of 12 columns per second. Thereafter the operator keys into the output card the variable numeric information, using the keyboard. When data from a record have been transmitted the operator ejects the card at the receiving end by pressing a special key, and this enables a blank card to be fed in for the next transmission.

The Receiving Station

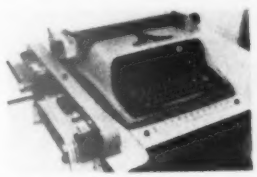
The central receiving station, which accepts the transmitted data and punches it into cards, is equipped with an IBM card punch modified with a data translator, a telephone (for voice communication) and a demodulating sub-set. When a transmission is to be made the telephone will be set to answer the call and punch the data automatically with minimum operator attention. The transmission of data is then monitored by automatic checking features, and if an error is detected at the necessary station, both it and the transmission station are automatically signalled. A total of 79 columns of information from several input cards can be combined into a single output card. Speed of operation of this method, which will of course vary considerably, depending on the amount and type of data transmitted, is about 8-12 card transactions a minute.

For further information tick Q01 on the reader enquiry coupon on page 44, or write to:
IBM (United Kingdom) Ltd.
101 Wigmore Street,
London, W1.

New Tape/Card Operated Typewriter

AN automatic typewriter which could operate from both tape and cards, and which would produce a by-product tape for subsequent processing, featured among the exhibits at the recent BEE.

First, the typewriter will type the master document, and will simultaneously record on tape or edge-punched cards all or part of the original document. The tape produced could then be further coded and used to activate a punch unit which would then produce a by-product or duplicate tape.



For invoices by paper tape

When, for example, a letter or invoice has to be typed, the typewriter would link up with the card and tape reading units. On the cards would be the name, address, account number, etc, of the customer. On the tape would be the text of the letter or the invoice narrative. The coded cards would control the card reader to type out the customer's name and address. As this was being done the information would be entered on by-product tape, so that the envelopes can be automatically typed. The continuous tape would store the text of the letter which would then be typed out. The reading speed of both tape and card is 600 codes per minute which is in fact 100 words per minute. Codes control both the tape and card handling, and stops can be written into every code to allow for the manual insertion. A code will also automatically switch in the punch to record manual typing. Codes also control the operation of the auxiliary punches and readers.

The makers feel that this method is of interest to business men, not only in respect of letter work, but also for control of purchase orders, production orders, stock control and a number of other functions. The BIMA takes up a working area of 48 inches by 30 inches and costs

ASK US

A great deal of information comes into the offices of AUTOMATIC DATA PROCESSING. Unfortunately we cannot publish all. But we retain everything—in files, on cards and in our heads. When queries arrive (on systems and products, books, courses, exhibitions, and even practical problems) we can usually provide an answer or find someone who can. Each month we publish in WHAT'S NEW the latest about new systems, services and equipment. We give below each item the address of the relevant company. But if you want further information and are too busy to write a letter, just fill in the coupon below.

Reader Enquiry Service

From WHAT'S NEW
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Q03... **Q04**... **Q05**...

Please advise me on the following additional problem

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NOW MAIL THIS COUPON TO: AUTOMATIC DATA PROCESSING, *Reader Enquiry Service, Mercury House, 109-119 Waterloo Road, London, SE1*

between £1,430—£1,978 plus any auxiliary equipment.

For further information tick Q02 on the reader enquiry coupon on this page, or write to:
British Equipment Co Ltd,
Auto-Typist Division,
Ixworth Place,
London, SW3.

New Alpha-Numeric Tape Punch

A MODIFIED alpha-numerical keyboard geared to an Addo-X adding-listing or book-keeping machine, and also to a tape-punch, is announced by Bulmer's (Calculators) Ltd. This will allow alpha-numeric data to be fed into tape, for subsequent data processing.

The keyboard is the controlling factor in this system, the shift keys being used to determine whether numeric or alphabetical codes are to be punched. When the operator depresses either of the sets of keys, the control code is punched and the keyboard becomes 'live'; thereafter as the figure/letter keys are depressed the information is punched direct into the tape.

To switch the adding-listing machine into circuit the operator depresses a third control key. This will have the effect of punching a 'figures' code into the tape; by this means figures can only be punched through the adding-listing machine according to a pre-wired programme. Figures can then either be punched in block form when pre-zeros would be punched automatically to pre-determined field sizes. Alternatively, a switch on the tape-punch may be turned on, to allow only significant digits to be punched.

The control keyboard would be used to switch the adding-listing machine out of circuit for direct punching, and this keyboard can also serve as the operating medium for making individual entries, and for actuating the various adding-listing machine functions, such as plus, minus and total.

The tape punches could be wired to punch any desired code, and are equipped with a pre-set counter for preparing computer tape. In this way a warning light can signal when the permissible number of digits has been entered, where the size of the block of information is limited.

The tape-punch could have five, six, seven or eight channel capacity.

For further information tick Q03 on the reader enquiry coupon on this page, or write to:
Bulmer's (Calculators) Ltd,
47-51 Worship Street,
London, EC2.

Pre-fabricated Filing Units

A PRE-FABRICATED multiple filing unit has just come on the market which offers considerable saving in capital outlay.

The components of this filing system consists of five units—a top-piece, two side panels, a back-panel and a base. Each new additional unit utilises part of the original unit as a common component; *ie*, two units back to back would use the same back panel, etc. In this way the maximum utilisation of floor

Extra keyboard allows alpha-numeric data to be punched

space can be achieved, with the greatest possible use of common units. The filing unit has a capacity of three and a half times that of a conventional four-drawer filing cabinet.

For further information tick Q04 on the reader enquiry coupon on page 44, or write to:
Shannon Ltd.
Shannon Corner,
New Malden,
Surrey.

Controls Paper Web

A REEL unit which allows for the electronic control of web feed is announced by A J Catlin Ltd. This method will allow for the continuous or intermittent feed of single webs of paper at rates up to 19.5 inches per second.

The tension on the web starts the motor of the drive unit, which is of the belt-type hinged at the top, the weight of the drive motor pressing the belts into contact with the surface of the reel. If the tension ceases, due to the cessation of the data processing, the drive is instantly interupted, and the belt restrains the reel from over-running; in the same way the speed of the motor is controlled by the tension on the web.

The reel is supported on a robust frame, and the web is fed therefrom over a delicately balanced control bar and into a tabulator or other output printer. This processing unit puts tension on the web, lifting the control bar, and thus closes a contact which starts the drive-unit in contact with the reel.

Because of the positive control which this offers and the elimination of tension, the risk of paper tearing is substantially reduced. Thus paper as fine as 30 grams or as heavy as 250 grams can equally be used on the Reelomat.

For further information tick Q05 on the reader enquiry form on page 44, or write to:
A J Catlin Ltd.
Jasper Road,
London, SE19.

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RATES: APPOINTMENTS VACANT, 3s. 6d. per line (minimum 3 lines), 40s. per display panel inch. APPOINTMENTS WANTED, 3s. per line, 35s. per display panel inch. Box No. charge, 1s. extra. Address advertisements to The Classified Advertisements Manager, "Automatic Data Processing," 109-119 Waterloo Road, London, S.E.1. Tel.: WATerloo 3388 (Ext. 32).

APPOINTMENTS VACANT

FORMICA LIMITED

A Member of The De La Rue Group

require a

DATA PROCESSING MANAGER

to lead a team carrying out detailed preparation work for the installation of a De La Rue Bull "500 Series" computer to be used initially for sales and production control.

The right man for this progressive post will have outstanding personality, experience and the ability to gain the respect and co-operation of management and staff at all levels. He should have experience of Data Processing in manufacturing industry backed by a degree or professional qualification. Age 28-35. Training will be given.

This post will involve work both in London and Tynemouth. The salary will be commensurate with age and experience. Excellent superannuation scheme.

Applications should be addressed to:

Personnel Officer,

FORMICA LIMITED,

De La Rue House, 84/86 Regent Street, W.1,

giving details of age, education and experience.

DE LA RUE BULL MACHINES LIMITED

an Associate of the De La Rue Group of Companies

De La Rue Bull Machines Ltd. offer excellent career opportunities in the electronic computer and electro-mechanical data processing field for

ELECTRO-MECHANICAL ENGINEERS

to specialise in training and administration in a rapidly expanding organisation.

Applicants should be between the ages of 28 and 38 and should possess an engineering degree and/or be corporate members of the Institutions of Mechanical or Electrical Engineers. They should have specialised in instrument and light mechanical engineering. Aptitude for teaching is essential.

Training will be given in France and a good knowledge of French is therefore required. Commencing salary, depending on age and experience, between £1,000 and £1,600 per annum.

Apply in writing to Personnel Officer:

De La Rue Co. Ltd., Berger House, Berkeley Square W.1.

Shell Chemicals

Petrochemicals Limited have a vacancy for a

PROGRAMMER

to prepare programmes for an I.C.T. "555" calculator. Candidates should have experience of punched card methods in general; knowledge of the I.C.T. "555" calculator would be an advantage but is not essential since training will be arranged if necessary.

Attractive salary commensurate with experience and ability, excellent contributory Pension Scheme and staff cafeteria; also good social and sports amenities.

Written applications, bearing reference ADP/66 should be sent to:—

Staff Manager,

Petrochemicals Ltd., Carrington Works,

Urmston, Manchester.

SMITHS

Expansion of the Company's work in Organisation and Methods and Electronic Data Processing has created vacancies in both fields. These will be of special interest to young men who wish to extend their experience in Organisation and Methods work and/or Electronic Data Processing investigation and planning.

ORGANISATION AND METHODS

Junior Systems Analysts, aged 23-27 are required to carry out examination and analysis of existing clerical systems (both manual and mechanised) and to assist experienced personnel in the development of new and improved procedures.

The successful applicants will have a general commercial background and be familiar with systems analysis techniques.

The prospects for future progress are excellent and these appointments should lead to more senior positions when fully experienced.

ELECTRONIC DATA PROCESSING

A job with a challenge and a future is available for a man, aged 25-35, with Computer experience, as Assistant Team Leader of the EDP Planning Team.

The Team's work involves the investigation of the proposed areas of application and the development of an integrated EDP system for production control, standard costing and payroll. The successful applicant will have had experience of planning, development and programming of commercial data processing systems and will be capable of contributing specialised knowledge of computer techniques to the existing Team.

This is an exceptional opportunity for a young man who wishes to take a leading part in a new venture with excellent prospects of assuming a senior position in the EDP field.

- *For these posts a degree or professional qualification will be an advantage, but preference will be given to applicants who have appropriate training and/or experience.*
- **Attractive commencing salaries, commensurate with qualifications and experience, will be offered, together with staff pensions and assurance benefits.**
- *Applications giving details of age, qualifications, present salary and brief details of previous experience will be treated in confidence and should be addressed, quoting reference S.M.341, to:*

The Staff Manager,

S. SMITH & SONS (ENGLAND) LIMITED

Cricklewood, London, N.W.2.

EMI

COMPUTER SYSTEMS ENGINEERING

THE SUCCESS of the EMIDEC range of computers continues and this has resulted in the need for additional Computer Systems Engineers.

THE TASK of a Computer Systems Engineer is to ensure that the Computer System functions satisfactorily. He must, therefore, be capable of appreciating all aspects of such a system, i.e., Engineering, logics, programming and operational control. He should accordingly have a thorough grasp of basic electronics, a clear logical approach to problems and should not be frightened of taking the considerable responsibility that the job involves.

THE MEN we want are those with computer experience who wish to progress their careers, for these appointments offer excellent opportunities.

In addition we want young men without computer experience but who have the technical and personal qualifications described, for we are prepared to train them in this exciting branch of industry.

Please write, giving full details and quoting Ref. **EL/13/SE**, to:

Personnel Manager,

E.M.I. ELECTRONICS LTD.,

HAYES, MIDDLESEX.

MALE COMPUTER MACHINE OPERATORS

required at the

ATOMIC ENERGY ESTABLISHMENT WINFRITH, DORSET

to operate the Mercury Electronic Computer on a shift basis.

Experience with punched cards, paper tape and similar equipment will be an advantage, although successful applicants will be given a course of training.

Appointments will be made in either the Machine Operator, Scientific or Senior Scientific Assistant grade, according to qualifications and experience. The minimum qualification for Scientific and Senior Scientific Assistant is G.C.E. at "A" level in four subjects (to include English and a Scientific or Mathematical subject), O.N.C. or equivalent.

Pay. In ranges between £505 (at age 23) and £1,105 per annum.

Superannuation and Assisted Travel Schemes. Good working conditions.

Please send POSTCARD for application form to Personnel Branch (W331/297), U.K.A.E.A., A.E.E., Winfrith, Dorchester, Dorset, not later than November 5, 1960.

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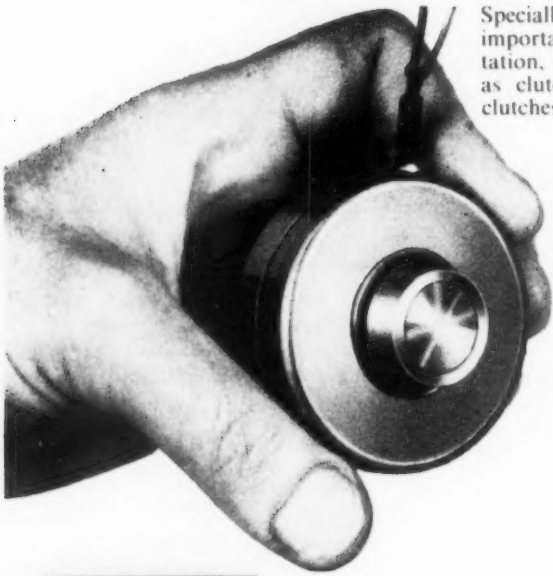

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